

AMPEX

1809993-01

VR-3000
Portable Videotape
Recorder

Operation and Maintenance
Manual

ISSUED: JULY 1969

LIST OF EFFECTIVE PAGES

Page	Issue Date	Page	Issue Date
Title Page	Original		
A	Original		
i thru xvi	Original		
Section I Tab	Original		
1-1 thru 1-8.	Original		
Section II Tab	Original		
2-1 thru 2-8.	Original		
Section III Tab	Original		
3-1 thru 3-12	Original		
Section IV Tab	Original		
4-1 thru 4-8.	Original		
Section V Tab	Original		
5-1 thru 5-34	Original		
Section VI Tab	Original		
6-1 thru 6-46	Original		
Section VII Tab	Original		
7-1 thru 7-6	Original		
Section VIII Tab.	Original		
8-1 thru 8-16	Original		
Section IX Tab	Original		
9-1 thru 9-34	Original		
Section X Tab	Original		
10-1 thru 10-62	Original		
Section XI Tab	Original		
11-1 thru 11-144	Original		

NOTICE

Only proper use will produce the high performance and reliability for which your Ampex equipment was designed, built, and tested. In order to be sure that you obtain the best possible performance and reliability, please DO NOT:

- INSTALL or CONNECT,
- OPERATE,
- ADJUST or ALIGN,
- MAINTAIN, or
- REPAIR

the equipment without first consulting the applicable portion(s) of the manual.

ERRATA

Date 2 December 1970

PUBLICATION VR-3000 Portable Videotape Recorder

No. 1809993

Errata No. 1

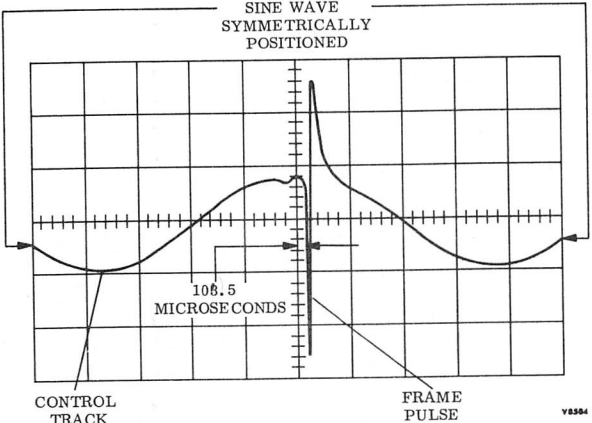
REASON FOR ERRATA To provide more specific control track adjustment information so that tapes recorded are compatible.

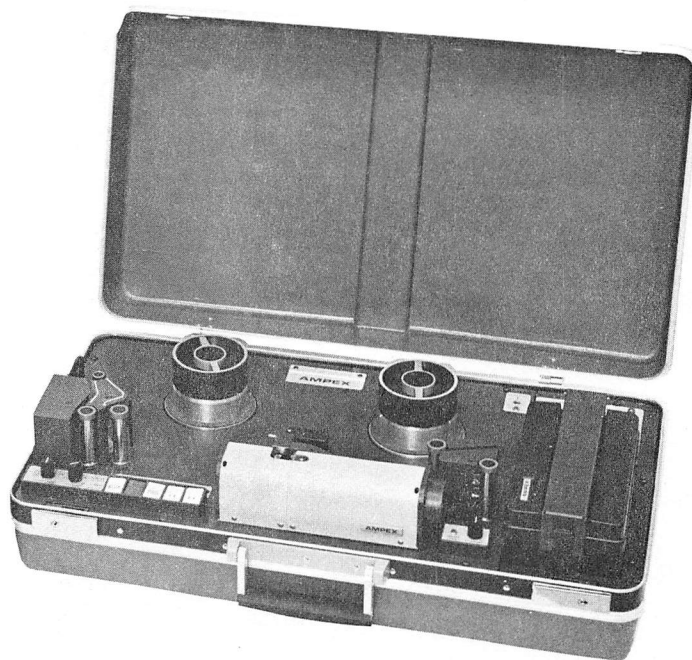
Page Reference	Nature of Errata
9-19	Delete existing steps <u>k</u> and <u>l</u> of paragraph 9-39 and replace with new text as follows: k. Using the 10:1 probe, connect a calibrated oscilloscope to CT REC test point and set the scope controls as follows: Vertical Sensitivity = 0.05 v/cm Horizontal Sweep = 5.0 ms/cm, magnified x10 l. Sync the scope to the control track and position the display so the sine wave peak with the frame pulse superimposed (every eighth peak) is symmetrically located between the outer edges of the graticule (see illustration on next page). m. Adjust control track phase potentiometer R1 on board 14 until the frame pulse leading edge trails the peak of the control track by 103.5 microseconds (9°), as shown in the typical waveform illustration on the next page. NOTE Considerable care will be necessary in making this adjustment. Also, the accuracy of the adjustment depends largely on how precisely the display is located symmetrically, as specified in step <u>l</u>.

ERRATA

No. 1809993

Errata No. 1

Page Reference	Nature of Errata
	n. Press STOP pushbutton, disconnect test equipment, and restore equipment to original configuration.  CONTROL TRACK SINE WAVE SYMMETRICALLY POSITIONED 100.5 MICROSECONDS CONTROL TRACK FRAME PULSE V8354 Typical Waveform Display



V0001

VR-3000 Videotape Recorder

COMMUNICATING WITH AMPEX

SERVICE INFORMATION AND PARTS

FIELD ENGINEERING BULLETIN SERVICE (See note below)

Ampex provides a continuous technical support program for its products. This program is partially implemented through field engineering bulletins, which are published by the Ampex Technical Support Group. Approved modifications, information on special tools and accessories, and improved operating and maintenance techniques are typical of the information distributed in these bulletins.

If the installation of your system or accessory was supervised by an Ampex Field engineer, you will be sent these bulletins automatically. If this is not the case, contact the nearest Ampex field office or write to:

Ampex Corporation
Video Technical Support Group
401 Broadway
Redwood City, California 94063 USA

SERVICE AND REPLACEMENT PARTS (See note below)

For service and replacement parts, contact your nearest Ampex field office. If the installation of your system or accessory was supervised by an Ampex field engineer, you will be sent information regarding the location of the nearest field office. Alternatively, write to the Technical Support Group at the address shown above.

NOTE

In order for the technical support program to function properly, the user must ensure that his communication is addressed to the proper department, and that it includes the following information, most of which can be obtained from the system identification nameplate on the equipment.

1. System name
2. Model number (including revision number)
3. System number
4. Serial number
5. Power requirements
6. System modifications and special accessories
7. Date of purchase
8. Name and address of your organization
9. Job function to which communication should be addressed
10. Physical location of equipment

COMMUNICATING WITH AMPEX

INSTRUCTION MANUAL CHANGES

Another part of the Ampex program of technical support for its products is the continuous revision and modification of instruction manuals as the equipment is improved or modified. In order to ensure that you always receive this information, write to:

Ampex Corporation
Audio/Video Technical Publications Department
401 Broadway
Redwood City, California 94063 USA

NOTE

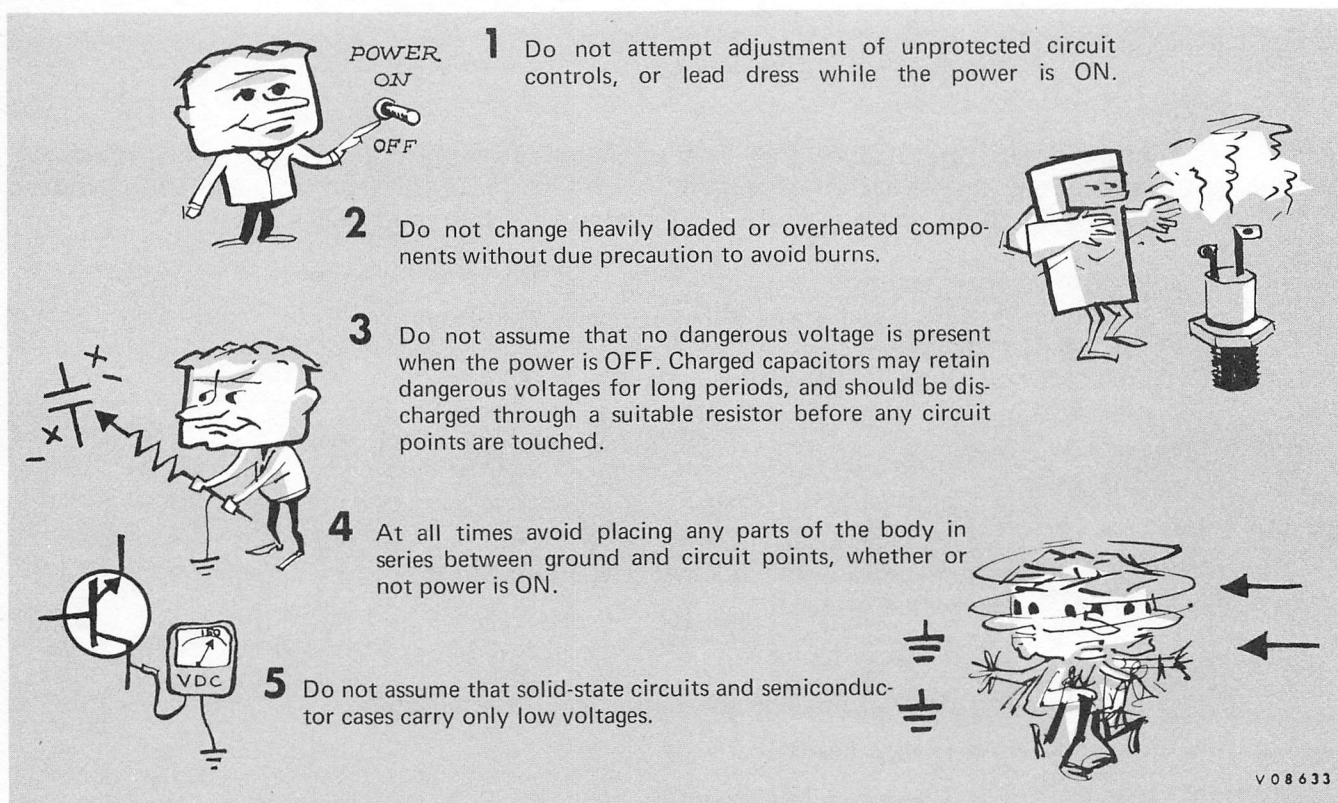
In order to be sure that you always receive information applicable to your equipment, please include the following information when you write to us:

1. System name
2. Model number (including revision number)
3. Serial number
4. Power requirements
5. System modifications and special accessories
6. Approximate date of purchase
7. Name and address of your organization
8. Job function to which communication should be addressed

SAFETY & FIRST AID

Because personnel working with electronic equipment are exposed to the hazard of high voltage, it is imperative that all safety regulations be consistently observed, and that each individual has a clear understanding of basic First Aid methods.

The following typical hazards must be avoided at all times:



For their own protection, and the protection of others, all electronic personnel should become thoroughly familiar with the approved First Aid treatment of burns and shock. There are three principal degrees of burns, recognizable as follows:

1. A first degree burn reddens the skin
2. A second degree burn blisters the skin
3. A third degree burn chars the flesh and frequently places the victim in a state of shock accompanied by respiratory paralysis.

Respiratory paralysis in the victim can cause death within seconds, by suffocation. For this reason it is imperative that the approved method of artificial respiration be initiated immediately and continued until the victim's breathing is normal.

A muscular spasm or unconsciousness may render the victim unable to free himself of the electric power. If this is the case, turn the power OFF immediately.

CAUTION

DO NOT TOUCH HIM, OR YOU MAY SHARE HIS PREDICAMENT.

If the power cannot be turned OFF immediately, **very** carefully loop a dry rope, article of clothing, length of strong cloth, or a rolled-up newspaper around the victim and pull him free of the power. Carefully avoid touching him or his clothing.

The moment he is clear of the power, place him in a reclining position, cover him with a blanket (or newspapers) to keep him warm, and begin artificial respiration. At the first opportunity, enlist help in the summoning of a doctor. If a doctor cannot be summoned, transport the victim to the doctor, infirmary, or hospital. Be sure that the victim is kept well covered and warm while awaiting professional aid and treatment.

TABLE OF CONTENTS

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
SECTION I	GENERAL INFORMATION	1-1
1-1	General Description of Equipment	1-1
1-10	Equipment Supplied	1-2
1-12	Accessories and Available Spares	1-2
1-14	Interchangeable Line Standards	1-5
1-16	Adjustments and Test Points	1-5
1-18	Specifications	1-6
SECTION II	INSTALLATION	2-1
2-1	Scope	2-1
2-3	Unpacking	2-1
2-6	Environment	2-1
2-9	Video Standard	2-1
2-12	Signal and Power Interconnections	2-1
2-15	Fixed Operation	2-2
2-23	Portable Operation	2-4
SECTION III	OPERATION	3-1
3-1	Scope	3-1
3-3	Operating Controls and Indicators	3-1
3-6	Familiarization and Checkout Procedures	3-6
3-8	Familiarization	3-6
3-12	Checkout Procedures	3-10
3-20	Operating Procedures	3-11
3-22	Initial Turn-on	3-11
3-24	Record Ready Mode	3-12
3-26	Record Mode	3-12
3-28	Playback Mode	3-12
3-30	Equipment Turn-off	3-12
SECTION IV	SYSTEM THEORY AND TAPE TRANSPORT THEORY	4-1
4-1	General	4-1
4-3	Overall Theory of Operation	4-1
4-4	Recorded Signals	4-1
4-6	Rotary Head Recording	4-2
4-12	Video Recording	4-2
4-15	Audio Recording	4-2

TABLE OF CONTENTS (Continued)

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
SECTION IV	SYSTEM THEORY AND TAPE TRANSPORT THEORY (Continued)	
4-17	Servo System	4-4
4-22	Tape Transport Theory of Operation	4-4
4-26	Capstan Assembly	4-4
4-30	Vacuum System	4-4
4-32	Supply Reel Assembly	4-6
4-36	Take-up Reel Assembly	4-6
4-39	Compliance Arms and Strain Gauges	4-6
4-41	Mark XI Head Assembly	4-6
4-44	Brushless DC Motor	4-6
4-46	Video Head Drum	4-7
4-48	Dual Tachometer	4-7
4-50	Rotary Transformer	4-8
4-52	Control Track Head	4-8
4-54	Adjustment Potentiometers	4-8
4-56	Audio Head Assembly	4-8
SECTION V	VIDEO SIGNAL SYSTEM THEORY	5-1
5-1	General	5-1
5-4	Video Signal Path Components	5-1
5-6	Record Mode Electronics	5-1
5-11	Playback Electronics	5-5
5-15	Standards Electronics	5-6
5-19	Input Video (Board #18)	5-6
5-25	Pre-Emphasis Driver and Video Clamp	5-8
5-28	Video Level Detector	5-8
5-31	Pre-Emphasis	5-8
5-33	Modulator/Preamplifier (Board #21)	5-8
5-34	Frequency Control	5-8
5-36	Multivibrator	5-8
5-43	Starting Oscillator	5-10
5-45	Record Head Drivers	5-11
5-49	Record Playback Switching	5-13
5-54	Preamplifiers	5-13
5-57	Switcher Equalizer (Board #22)	5-13
5-60	Switchers Channel Amplifiers	5-19
5-67	Switcher Logic	5-19
5-81	Cosine Equalizer	5-24

TABLE OF CONTENTS (Continued)

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
SECTION V	VIDEO SIGNAL SYSTEM THEORY (Continued)	
5-85	RF Low Pass Filter	5-27
5-87	Envelope Detector	5-27
5-89	Demodulator Filter Amplifier (Board #23)	5-27
5-91	Limiters	5-27
5-93	Demodulator	5-27
5-96	Low Pass Filter and Phase Equalizer	5-28
5-100	Output Amplifier	5-28
5-102	Transient Suppressor	5-29
5-104	Back Porch Clamp	5-29
5-106	Standards (Board #19)	5-29
5-108	De-Emphasis Network	5-29
5-111	Sync Processing Circuitry	5-31
5-114	Vertical Sync Separator	5-33
5-119	Video Output	5-33
SECTION VI	SERVO SYSTEM AND CONTROL CIRCUIT THEORY	6-1
6-1	General	6-1
6-3	Servo Systems	6-1
6-11	Head Drum Servo	6-2
6-12	Introduction	6-2
6-16	Motor Drive Circuitry	6-3
6-22	Drum Speed Control	6-4
6-27	Drum Phase Control	6-10
6-29	Drum Motor	6-10
6-32	Six-Tach	6-10
6-34	Once Around Pulse Generator	6-10
6-36	Six-Tach Pulse Generator	6-11
6-39	One Shot Delay (6-Tach)	6-11
6-44	Shift Counter	6-11
6-46	Starter	6-12
6-48	Motor Drive Switchers	6-12
6-52	Motor Drive Control Amplifier	6-12
6-54	Tachometer Time Error Cancellation	6-13
6-58	Discriminator (1440 Hz or 1500 Hz)	6-13
6-68	Amplifier Equalizer	6-17
6-71	Record Ramp Generator	6-17
6-76	Vertical Phase Comparator	6-17
6-80	Record Phase Error Amplifier	6-18

TABLE OF CONTENTS (Continued)

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
SECTION VI	SERVO SYSTEM AND CONTROL CIRCUIT THEORY (Continued)	
6-85	Capstan Servo	6-18
6-86	Introduction	6-18
6-92	Capstan Assembly	6-20
6-96	Speed Control	6-20
6-99	Phasing Control	6-20
6-103	Capstan Motor	6-23
6-105	Tachometer Discs	6-23
6-110	Eccentricity Cancel and Capstan Tach Preamplifier	6-23
6-113	Frequency Discriminator	6-24
6-119	Capstan Second Order Speed Control	6-24
6-122	Record Phase Comparator	6-25
6-126	Playback Phase Detector	6-25
6-130	Playback/Record Error Comparator	6-27
6-134	Control Track Circuitry	6-27
6-135	Introduction	6-27
6-139	Record Circuitry	6-27
6-143	Frame Pulse Generator and Servo Lock Selector	6-29
6-146	Playback Circuitry	6-29
6-148	Control Track Selector	6-31
6-150	Control Circuits	6-31
6-151	Introduction	6-31
6-154	Control Logic	6-31
6-156	Parking Brake Assembly	6-32
6-158	Vacuum Pump	6-32
6-160	Takeup Motor Driver	6-32
6-163	Supply Motor Driver and Brake Driver	6-32
6-165	Tape Tension	6-32
6-168	Guide Actuating Motor Assembly	6-32
6-171	Control Logic	6-33
6-174	Play Mode	6-33
6-179	Record/Ready Mode	6-34
6-184	Stop Mode	6-34
6-187	Rewind Mode	6-37
6-192	Rewind Backup	6-37
6-195	Record Mode	6-38
6-198	Fast Forward Mode	6-38
6-201	Local Servo Tally and Camera Tally Indicators	6-38

TABLE OF CONTENTS (Continued)

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
SECTION VI	SERVO SYSTEM AND CONTROL CIRCUIT THEORY (Continued)	
6-203	Tape Tension Control	6-38
6-206	Stop Mode	6-38
6-209	Play Mode	6-43
6-219	Fast Forward Mode	6-44
6-223	Rewind Mode	6-44
SECTION VII	AUDIO SIGNAL SYSTEM THEORY	7-1
7-1	General	7-1
7-3	Audio Signal System	7-1
7-7	Playback Circuitry	7-1
7-9	Recording Circuitry	7-2
SECTION VIII	POWER SUPPLY THEORY	8-1
8-1	General	8-1
8-3	3.6 Volt Power Supply	8-1
8-12	± 10 Volt Power Supplies	8-3
8-14	± 10 Volt Regulators	8-3
8-19	± 12 Volt Power Supplies	8-3
8-23	± 12 Volt SVO Regulators	8-4
8-31	± 12 Volt SIG Regulators	8-4
8-36	Power Distribution	8-7
8-38	Battery Eliminator	8-7
8-41	Power Input	8-7
8-43	Voltage Regulator	8-8
8-46	Balance Shunt Regulators	8-9
8-49	Battery Pack	8-9
8-52	Charging Procedures	8-9
8-54	State of Charge	8-10
8-56	Battery Interconnections	8-10
8-59	Battery Charger	8-10
8-66	Power Transformer, Rectifier, and Filter	8-13
8-72	Charging Circuits	8-13
8-78	Metering Circuit	8-14
SECTION IX	MAINTENANCE	9-1
9-1	Introduction	9-1

TABLE OF CONTENTS (Continued)

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
SECTION IX	MAINTENANCE (Continued)	
9-3	Tools and Test Equipment	9-1
9-5	Variable Controls.	9-1
9-7	Preventive Maintenance.	9-1
9-9	Heads and Tape Path Cleaning	9-8
9-11	Video and Audio Head Degaussing	9-8
9-15	Battery Power Pack Recharge	9-9
9-17	Battery Power Pack Inspection and Cleaning	9-10
9-21	Trouble Analysis	9-10
9-29	Mark XI Video Head Preventive Maintenance Tips	9-12
9-31	Corrective Maintenance	9-13
9-34	Drum Servo Adjustment	9-16
9-36	Capstan Servo Adjustment	9-17
9-38	Control Track Adjustment	9-18
9-40	Playback Speed Adjustment	9-19
9-42	Video Head RF Driver Adjustment	9-20
9-44	Torque Adjustment	9-20
9-46	Tape Tension Adjustment	9-20
9-48	3.6 VDC Power Supply Adjustment	9-21
9-50	±12V Regulator Adjustment	9-21
9-52	Lubrication	9-22
9-54	Vacuum Adjustment	9-22
9-56	AC Power Pack Adjustment	9-22
9-58	Battery Power Pack	9-23
9-61	Battery Power Pack Cell Replacement	9-23
9-63	Vacuum Tape Guide Standard Position Check	9-24
9-65	Video Head Transformer Adjustment	9-25
9-67	Tip Projection Measurement	9-25
9-69	Waveforms	9-26
SECTION X	SCHEMATICS	10-1
10-1	General	10-1
SECTION XI	ILLUSTRATED PARTS BREAKDOWN	11-5
11-1	Introduction	11-5
11-4	Group Assembly Parts Lists	11-5
11-6	Figure and Index Number	11-5

TABLE OF CONTENTS (Continued)

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
SECTION XI	ILLUSTRATED PARTS BREAKDOWN (Continued)	
11-8	Part Number.	11-5
11-10	Asterisk (*)	11-5
11-12	Description	11-5
11-14	Units Per Assembly	11-7
11-16	Usable On Code	11-7
11-18	Numerical Index	11-7
11-20	Vendor Information	11-7

LIST OF ILLUSTRATIONS

<u>Fig. No.</u>	<u>Title</u>	<u>Page</u>
Frontispiece	VR-3000 Videotape Recorder	v
SECTION I	GENERAL INFORMATION	
1-1	Equipment Supplied with VR-3000 VTR	1-4
SECTION II	PREPARATION FOR USE	
2-1	Locations of Signal and Power Connections on VR-3000 VTR	2-3
2-2	Portable Operation Using Alpine-Type Back-Pack	2-6
SECTION III	OPERATION	
3-1	VR-3000 VTR Operating Controls and Indicators	3-4
3-2	VR-3000 Battery Charger Operating Controls and Indicators	3-7
3-3	Tape Threading Path in VR-3000 VTR	3-9
SECTION IV	SYSTEM THEORY AND TAPE TRANSPORT THEORY	
4-1	Tape Track Location	4-1
4-2	Video Track Spacing	4-3
4-3	Tape Transport	4-5
4-4	Mark XI Head Assembly	4-7
SECTION V	VIDEO SIGNAL SYSTEM THEORY	
5-1	Signal System Overall Block Diagram	5-3
5-2	Input and Output Video Block Diagram	5-7
5-3	Totem-Pole Amplifier, Simplified Schematic	5-9
5-4	Pre-Emphasis Network	5-11
5-5	Modulator Preamplifier Block Diagram	5-12
5-6	Record/Playback Switching Simplified Schematic	5-14
5-7	Switcher Equalizer Block Diagram	5-15
5-8	Switcher Channel Amplifier	5-17
5-9	Switcher Logic Block Diagram	5-20
5-10	Switching Logic Timing Waveforms	5-21
5-11	Cosine Equalizer and Envelope Detector Block Diagram	5-24
5-12	Demod Filter Amplifier Block Diagram	5-25
5-13	Demodulator Functions	5-28
5-14	Standards Block Diagram	5-30
5-15	De-Emphasis Network	5-31
5-16	Sync Processing Block Diagram	5-32

LIST OF ILLUSTRATIONS (Continued)

<u>Fig. No.</u>	<u>Title</u>	<u>Page</u>
SECTION VI	SERVO SYSTEM AND CONTROL CIRCUIT THEORY	
6-1	Head Drum Servo, Simplified Block Diagram	6-2
6-2	Capstan Servo, Simplified Block Diagram	6-3
6-3	Head Drum Servo, Functional Block Diagram	6-5
6-4	MDA Timing Waveforms	6-7
6-5	Drum Speed Control, Block Diagram	6-9
6-6	Drum Speed Control Timing Waveforms	6-15
6-7	Capstan Servo Block Diagram	6-19
6-8	Capstan Servo Timing Waveforms	6-21
6-9	Capstan Speed Control Block Diagram	6-26
6-10	Control Track Block Diagram	6-28
6-11	Control Logic Block Diagram	6-30
6-12	Reel Servo and Guide Actuation Motor Block Diagram	6-31
6-13	Play-Diode Control Logic Circuitry, Simplified Schematic	6-33
6-14	Record Ready Diode Control Logic Circuitry, Simplified Schematic	6-35
6-15	Stop Mode Control Logic Circuitry, Simplified Schematic	6-36
6-16	Tension Control - Stop Mode, Simplified Schematic	6-39
6-17	Tension Control - Play Mode, Simplified Schematic	6-40
6-18	Tension Control - Fast Forward Mode, Simplified Schematic	6-41
6-19	Tension Control - Rewind Mode, Simplified Schematic	6-42
SECTION VII	AUDIO SIGNAL SYSTEM THEORY	
7-1	Audio Signal System	7-3
SECTION VIII	POWER SUPPLY THEORY	
8-1	+3.6 Volt Power Supply	8-2
8-2	±10 Volt Regulators	8-2
8-3	±12 Volt SVO Regulators	8-5
8-4	±12 Volt SIG Regulators	8-6
8-5	Battery Eliminator	8-8
8-6	Battery Charging Curve	8-10
8-7	Battery Discharging Curve	8-11
8-8	Battery Charger	8-12
8-9	Voltmeter Circuit	8-15

LIST OF ILLUSTRATIONS (Continued)

<u>Fig. No.</u>	<u>Title</u>	<u>Page</u>
SECTION IX MAINTENANCE		
9-1	Transistor Symbols and Diode Equivalents	9-11
9-2	Normal Resistances Between Transistor Terminals	9-12
9-3	VR-3000, Bottom View	9-14
9-4	VR-3000, Near Side View	9-15
9-5	VR-3000, Left Side View	9-15
9-6	Control Track Waveform	9-19
9-7	Picture Skewing of Vertical Bar Test Signal	9-24
9-8A	Tip Projection Measurement Test Setup	9-26
9-8B	Tip Projection Gauge	9-27
9-9	Oscillograms (7 Sheets)	9-28
SECTION X SCHEMATICS		
10-1	Tape Transport Assembly, Wiring Diagram	10-3
10-2	Standards Kit, 525 HB/525 LB	10-5
10-3	Standards Kit, 625 HB/625 LB	10-7
10-4	Standards Kit, 819 HB/819 LB	10-9
10-5	Standards Kit, 625 HB/405 LB	10-11
10-6	Standards Kit, 625/819 HB	10-13
10-7	Demodulator Filter	10-15
10-8	Input and Output Video	10-17
10-9	Modulator Preamplifier	10-19
10-10	Switcher Equalizer	10-21
10-11	Audio AGC Amplifier	10-23
10-12	Audio Head Drive	10-25
10-13	Parking Brake Assembly	10-27
10-14	Control Logic	10-29
10-15	Power Distribution	10-31
10-16	+3.6 VDC Regulator	10-33
10-17	±12V Regulator	10-35
10-18	Rewind Motor and Supply Brake Drivers	10-37
10-19	Take Up Motor Driver	10-39
10-20	Guide Retraction	10-41
10-21	Drum MDA Driver	10-43
10-22	Drum Servo	10-45
10-23	Control Track	10-47
10-24	MDA Head Drum	10-49
10-25	Capstan Servo	10-51

LIST OF ILLUSTRATIONS (Continued)

<u>Fig. No.</u>	<u>Title</u>	<u>Page</u>
SECTION X SCHEMATICS (Continued)		
10-26	Capstan Assembly	10-53
10-27	Head Assembly	10-55
10-28	Battery Charger, Wiring Diagram	10-57
10-29	Battery Charger, Schematic	10-59
10-30	Battery Eliminator (AC Power Pack)	10-61
SECTION XI ILLUSTRATED PARTS BREAKDOWN		
11-1	Videotape Recorder Assembly	11-3
11-2	Recorder Assembly (2 sheets)	11-13
11-3	Audio Head Drive (Board 25)	11-17
11-4	PWA Standards (525 HB-525 LB) (Board 19) (2 sheets)	11-19
11-5	PWA Standards (625 HB-625 LB) (Board 19) (2 sheets)	11-23
11-6	PWA Standards (819 HB-819 LB) (Board 19) (2 sheets)	11-27
11-7	PWA Standards (625 HB-405 LB) (Board 19) (2 sheets)	11-31
11-8	PWA Standards (625 HB-819 HB) (Board 19) (2 sheets)	11-35
11-9	Input/Output Video (Board 18) (2 sheets)	11-39
11-10	Supply Motor and Brake (Board 27) (2 sheets)	11-43
11-11	MDA Driver (Board 16) (2 sheets)	11-47
11-12	Drum Servo (Board 15) (4 sheets)	11-51
11-13	Control Track (Board 14) (2 sheets)	11-57
11-14	Capstan Servo (Board 13) (3 sheets)	11-61
11-15	Control Logic (Board 12) (2 sheets)	11-67
11-16	12 Volt Regulator (Board 11) (2 sheets)	11-71
11-17	Takeup Motor Driver (Board 26) (2 sheets)	11-75
11-18	Power Distribution (Board 20)	11-79
11-19	Audio AGC Amplifier (Board 24) (2 sheets)	11-81
11-20	Demodulator Filter Amplifier (Board 23) (4 sheets)	11-85
11-21	Switcher/Equalizer (Board 22) (4 sheets)	11-91
11-22	Modulator Preamplifier (Board 21) (4 sheets)	11-97
11-23	MDA Head Drum (Board 17) (2 sheets)	11-103
11-24	Tape Transport Assembly (4 sheets)	11-107
11-25	Battery Charger	11-118
11-26	PWA Battery Charger (Board 1 and 2)	11-121
11-27	PWA Battery Charger (Board 3)	11-123
11-28	Battery Eliminator	11-125
11-29	PWA Battery Eliminator	11-127

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
1-1	Equipment Supplied with VR-3000 VTR	1-2
1-2	Accessories and Available Spares	1-5
1-3	VR-3000 VTR Specifications	1-6
3-1	VR-3000 Operating Controls and Indicators	3-1
3-2	Battery Charger, Operating Controls and Indicators	3-5
5-1	Television Line Standards	5-1
5-2	Signal System Printed Wiring Assemblies	5-2
5-3	Level to Carrier Frequency Correlation	5-5
5-4	Pre-Emphasis Networks	5-10
5-5	De-Emphasis Network	5-29
7-1	Audio Input Switch Functions	7-2
8-1	Power Distribution Relay Operation	8-7
9-1	Commercial Tools and Test Equipment	9-2
9-2	Variable Controls	9-3
10-1	List of Schematics	10-1

SECTION I

GENERAL INFORMATION

1-1 GENERAL DESCRIPTION OF EQUIPMENT

1-2 The Ampex VR-3000 Video Tape Recorder (VTR) is a portable, battery-operated unit which records NTSC/PAL/SECAM color and monochrome tapes to SMPTE recommended practices and EBU standards. The VR-3000 uses the quadrature, transverse-scan, rotary head method of video recording with the head drum rotating at a speed of 240 revolutions per second (rps) for the 60 frame/525 line standard and 250 rps for the various 50 frame line standards. The tape moves at a speed of 15 inches per second (ips).

1-3 Since the VR-3000 weighs less than 55 pounds, it is capable of back-pack mounting. When used with a hand-held camera such as the Ampex BC-300, the VR-3000 provides television producers, stations, and networks with the freedom and flexibility of film, and yet maintains all of the features of magnetic recording, such as immediate replay for verification of a recorded sequence and elimination of film developing.

1-4 As a "one man show", the back-pack VTR produces quality tapes from the hand-held camera for on-the-spot coverage of news or special events. Other applications of the VR-3000 include:

a. Field video tape recorder with existing color or monochrome mobile camera van.

b. Backup recorder for a larger VTR such as the Ampex Model VR-1200 or Model VR-2000 studio recorder.

c. Surveillance data recorder in existing camera installations.

d. Built-in recorder in remote controlled aircraft, tanks, or submarines (drones).

e. On-location production of commercials without cumbersome van.

1-5 The VR-3000 is a completely solid state, portable recorder with numerous features for operational simplicity. Many of the large machine adjustments have been eliminated or automated, and only test points for bench-type setup adjustments are included in the unit. A dual time constant agc circuit in the audio portion of the VR-3000 eliminates the constant need of monitoring gain and adjusting when obtaining "close-up" audio.

1-6 The VR-3000 is equipped with a Mark XI Video Head assembly. Included with the head assembly is a brushless dc head motor and precision guide assembly. A small vacuum pump and miniature guide lifter motor in the VR-3000 provide the video heads with the same capabilities as the larger studio-type recorders. The tape transport has fast forward and rewind modes.

1-7 Tape motion control is performed by various servo systems which ensure precision-stability recordings. Playback circuitry is included to enable limited playback of the taped program into the viewfinder of the Ampex Model BC-300 camera (when used) or into an external monitor. No erase facilities are provided; tape erasure is performed by use of a bulk tape degausser such as the Ampex Model SE-10.

1-8 The VR-3000 has a rigid frame in a shock-proof case, and special compliance arms which minimize vibration effects. Low frequency disturbances are automatically compensated by the tape tension servos, the capstan speed servo, and the head drum servo. The capstan is thinly coated with rubber and the combination of this coating with the angle of tape wrap around the capstan eliminates the need for a pressure roller to hold the tape against the capstan. The VR-3000 operates in any position (except fully inverted when used with the battery pack). When the VTR is used with the supplied battery eliminator, it operates in any position.

1-9 The VR-3000 VTR is designed to be operated from either its own self-contained batteries, when a source of ac power is not available, or from a source of 115/220 volts, 50/60/400 Hz power. An alpine-type back-pack is available as an accessory item so

that the recorder may be "worn" when it is necessary that the operator be mobile. When a source of automotive power (6, 12, or 28 vdc) is available, a user-obtained converter may be used to supply 115-volt ac power; the ac power pack in this case must be installed in the VTR.

1-10 EQUIPMENT SUPPLIED

1-11 Table 1-1 lists the equipment supplied with the VR-3000. Also included in this table are the quantities and Ampex part numbers. The equipment supplied with the VR-3000 is shown in Figure 1-1.

1-12 ACCESSORIES AND AVAILABLE SPARES

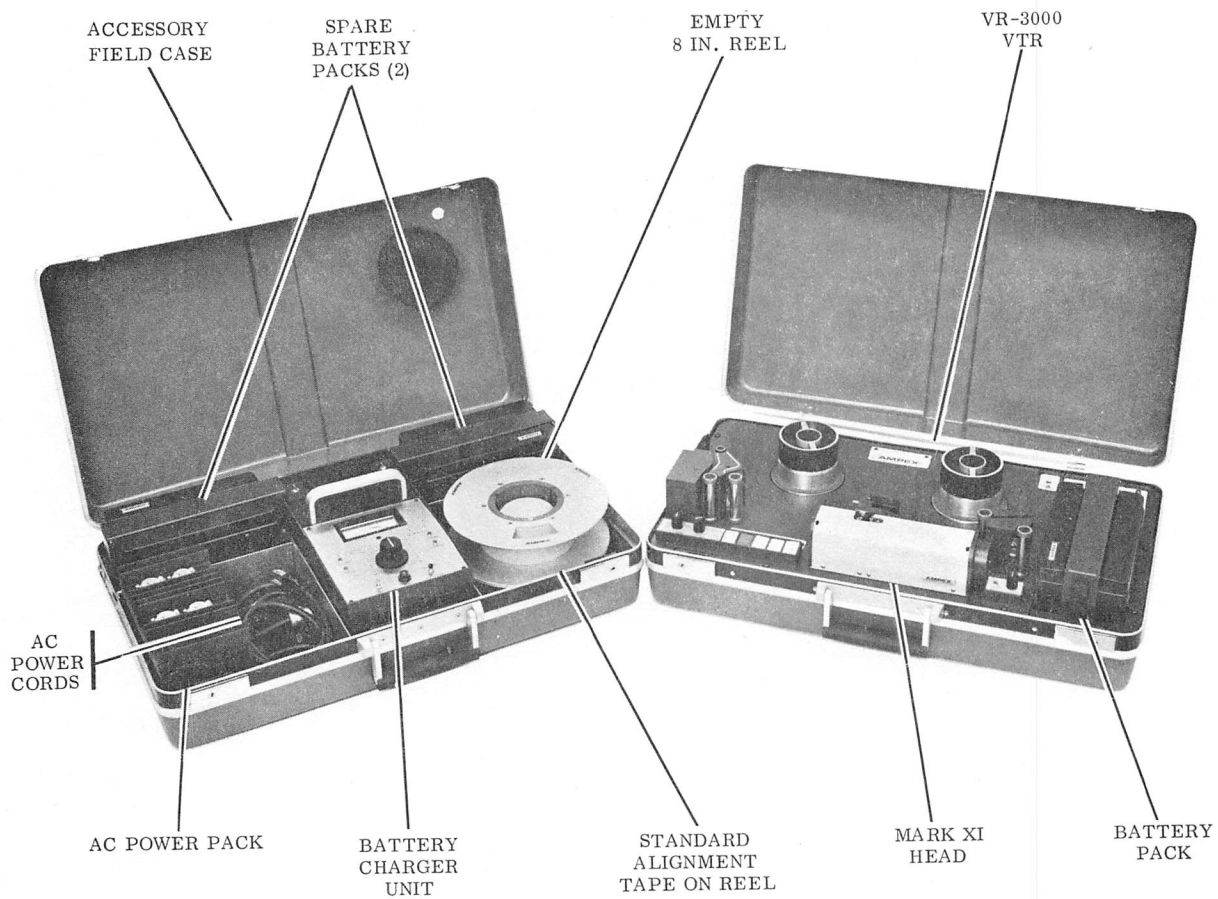
1-13 Table 1-2 lists the accessories and available spares for the VR-3000. Also included in this table are Ampex part numbers.

Table 1-1. Equipment Supplied with VR-3000 VTR

QUANTITY	DESCRIPTION	AMPEX PART NO.
1	Basic VR-3000 assembly in field case	1805278-02
1	Standards kit from the following:	
	525/525 (HB/LB)	1805297-01
	625/625 "	1805297-02
	819/819 "	1805297-03
	625/405 "	1805297-04
	625/819 (HB/HB)	1805297-05
1	Maintenance parts kit (Two versions of this kit are available and are identical except for the items listed with the asterisk.) The kit includes:	1363616-03 1363616-04
	1 Tip projection gauge	1218210-01
	1 Extender board	1242977-01
	1 Extender board (22 pin)	1361682-01
	1 Extender board (18 pin)	1361689-01
	1 Extender board (10 pin)	1363422-01
	2 Power cables (115 volt)* (Supplied with -03 kit)	1363360-01*
	2 Power cables (220 volt)* (Supplied with -04 kit)	1363361-01*
	4 Bench support posts	1363617-01

Table 1-1. Equipment Supplied with VR-3000 VTR (Continued)

QUANTITY	DESCRIPTION	AMPEX PART NO.
	Maintenance parts kit (cont.)	
	4 Bench support posts	1363617-02
	1 Head demagnetizer	4010820-01
	2 Battery cells (battery pack spares)	1380142-01
	1 Pint gray lacquer	087-201
	1 14-pin connector for remote control	143-795
	1 Hex screw driver	360-170
	1 0-2 lb. dial indicator	650-105
	1 Empty 8 inch precision reel	28050-02
2	Instruction manuals	1809993-01
1	Alignment tape from the following:	
	525/60 line standard	50262-07
	625/50 line standard	50282-04
1	Mark XI Video Head Assembly	1805180-01
3	Battery power pack	1805276-01
1	Battery charger	1805275-02
1	Accessory field case	1363813-01
1	Back pack rack	1805284-01
1	Adaptor tray for mounting ac power pack in accessory field case	1805283-01
1	Microphone, Model 803	4010803-10
1	Headset, Telex Model HS-2000	095-024
1	A. C. Power pack (battery eliminator)	1805258-02



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Figure 1-1. Equipment Supplied with VR-3000 VTR

Table 1-2. Accessories and Available Spares

DESCRIPTION	AMPEX PART NO.
Empty "8" precision reel	28050-03
Standards Kit (819 HB/LB)	1805297-03
Standards Kit (625 HB/405 LB)	1805297-04
Standards Kit (625 HB/819 LB)	1805297-05
Level A Spares Kit (525 HB/LB)	1230981-10
Level A Spares Kit (625 HB/LB)	1230981-20
Level A Spares Kit (819 HB/LB)	1230981-30
Level A Spares Kit (625 HB/405 LB)	1230981-40
Level A Spares Kit (625 LB/819 HB)	1230981-50
Major Mechanical Spares Kit	1230982-10
Minor Mechanical Spares Kit	1230982-20
Level B Spares Kit	1230983-10
Battery Pack (spare)	1805276-01
Mark XI Video Head (Spare)	1805180-01
Accessory Field Case (Spare)	1363813-01
Back-pack Alpine Back Rack	1805284-01

1-14 INTERCHANGEABLE LINE STANDARDS

1-15 The VR-3000 operates in the various 60 frame and 50 frame television line standards. All circuitry which determine the line standard are located on a plug-in printed circuit board. A switch, located on the front panel, selects either of two line standards, which in turn are defined by the particular printed-circuit "standards board". The various standards boards, and the selected position of the STD SELECT switch are described in Table 5-1.

1-16 ADJUSTMENTS AND TEST POINTS

1-17 Front panel adjustments, available for an operator to perform routine maintenance, are included on the tape transport. A panel of test points is also provided, for routine checkout procedures. Because of its portable nature, the VR-3000 VTR is designed with a minimum of field adjustments; this is in contrast to the large studio recorders. Maintenance and adjustment procedures are included in Section IX.

1-18 SPECIFICATIONS

1-19 Specifications for the VR-3000 VTR are given in Table 1-3. Because of possible design improvements or equipment modifications, all specifications listed in this section are subject to change without notification.

Table 1-3. VR-3000 VTR Specifications

CHARACTERISTIC	SPECIFICATION
Video signal performance	
Bandwidth	Bandwidth characteristics are determined by the specifications of the recorder which is used to play back tapes made on the VR-2000; refer to the appropriate instruction manual.
Signal-to-noise ratio	
Low-band monochrome 525/60	43 dB minimum
High-band 525/60	44 dB minimum
Low-band 625/50	41 dB minimum
High-band 625/50	41 dB minimum
Composite video input level	1.0 Vp-p nominal; 0.5 Vp-p minimum; and 1.5 Vp-p maximum
Input impedance	75 ohms ($\pm 1\%$), unbalanced
Line/frame standards	405/25, 525/30, 625/25, 819/25
Differential phase	Less than 5 degrees at 3.58 MHz off tape
Differential gain	Less than 7% from blanking to peak white at 3.58 MHz
Operating characteristics	
Record time	20 minutes maximum with 1.4 mil tape
Reels	8 inch reels per USA Standard C985-1965
Tape speed and format	15 ips (on 60 field scanning systems) transverse scan; fully compatible with SMPTE Recommended Practices, and USA and EBU Standards

Table 1-3. VR-3000 VTR Specifications (Continued)

CHARACTERISTIC	SPECIFICATION
Operating characteristics (cont.)	
Low-band/high-band operation	Video signal system performs in accordance with Recommended Practice RP6 (low-band monochrome or high-band NTSC color) of SMPTE Standards. EBU Standards for low-band monochrome and high-band monochrome or color (PAL or SECAM) recordings are also met.
Audio signal performance (program channel only)	
Bandwidth	±3 dB, 50 Hz to 10 kHz
Signal-to-noise ratio	45 dB (minimum) referred to peak operating level
Input Impedance	150/250 ohms microphone balanced line, or switchable to bridging line input
Gain control	Multiple-time-constant agc circuit with 50 dB of control range
Input level	
Microphone	-50 to -60 vu
Bridging, line agc on	-20 vu to +24 vu, nominal
Bridging, line agc off	+8 vu

SECTION II

INSTALLATION

2-1 SCOPE

2-2 This section contains the information necessary to unpack and place an Ampex Model VR-3000 VTR into operation. Because of the various configurations (selection of power input and source of video and audio) in which the VR-3000 may be used, the various environments are discussed separately.

2-3 UNPACKING

2-4 The VR-3000 is shipped inside its carrying case, which is in turn strapped together with the accessory case, inside a shipping crate. To remove the VR-3000, lift the top of the crate with a crowbar, and then remove the sides of the crate. Cut the retaining straps and remove the VR-3000 and accessory case from the bottom of the crate.

2-5 Use extreme care when unpacking the equipment to prevent damage to the exterior of the carrying cases. Check all the equipment against the packing list.

2-6 ENVIRONMENT

2-7 Normally, the VR-3000 is intended for use in a broadcast studio or field location. In the studio, a supply of commercial ac power is available and will generally be used with the battery eliminator installed in the VR-3000. In the field, the VTR may be used while mounted on an alpine-type backpack with self contained battery packs installed. Also, the VR-3000 may be used inside a vehicle which has a source of 6 vdc, 12 vdc, or 28 vdc. In any case, the vehicle power must be converted to 115 vac using a

commercial power converter (not supplied by Ampex); the VR-3000 would then use the ac power pack (battery eliminator).

2-8 The site selected for use of the VR-3000 should be isolated from such electrostatic noise sources as motors, generators, rf fields, etc. When using the VTR without its protective cover (which would normally be the case, except when the recorder is used in the back-pack mounting arrangement), the selected site should also be relatively dust free.

2-9 VIDEO STANDARDS

2-10 The Ampex model VR-3000 is designed to produce video tapes in the various line standards normally used in American and European television systems. When originally supplied by Ampex, the Model VR-3000 is equipped with a selected standard board (as ordered by the user) installed into the electronics of the VTR. Also, for appearance, the designation strip (under the AUDIO INPUT and STD SELECT switches) is marked with the selected line standards system.

2-11 A standards modification kit is available if the user wishes to change the video standard system in which the VR-3000 is used. Installation instructions, a standards board, and the designation strip are supplied with the modification kit.

2-12 SIGNAL AND POWER INTER-CONNECTIONS

2-13 Installation of the VR-3000 is limited to signal and power interconnections between the recorder and the following:

a. Hand held camera (may include viewfinder and VTR controls, e.g., Ampex Model BC-300)

b. Video monitor

c. Microphone

d. Headset (field use)

e. Audio input line, +8 vu nominal, 600 ohms (studio use)

f. AC input (using the ac power pack), when ac power is available

2-14 Connections are located on the side and bottom of the VR-3000 VTR as shown in Figure 2-1.

2-15 FIXED OPERATION

2-16 Fixed operation of the VR-3000 implies operation where the unit is restricted to a particular operating location because of a limiting factor such as source of video, source of audio, or source of ac power. For example, an operating site has an outlet for the ac power, the audio and video are supplied from a manned console, and monitoring consoles are provided for production and direction personnel. In this case it may be assumed that the VR-3000 can be placed in a convenient location and operated from it for the duration of the session.

2-17 The ac power pack should be connected to the VR-3000 and used, instead of the battery pack. Audio from the external amplifier is connected to AUDIO INPUT jack J2. Video input is connected to J7.

NOTE

If a camera is connected directly to the VR-3000 and is used as the source of video, the VIDEO INPUT at J7 must be disconnected. Input signals, simultaneously present at the camera input jack J1 and the video input jack J7 mix

to produce beat interference patterns and other unpredictable results.

2-18 CONNECTING AC POWER PACK.

The ac power pack is directly interchangeable with the battery pack, when a source of ac power is available. The ac power pack is placed into the battery-well in the same position as the battery pack (when it is used). The ac power pack must be positioned so that the printed circuit connector is placed at the far end, away from the operator; the ac connector should be located at the right-hand side. Use the following procedure to install the ac power pack into the VR-3000.

a. Loosen the fastener holding the power-case clamp. Pull the top of the fastener until it moves over-center, then lower the whole assembly until it clears the bottom wedge of the stationary part. Pull the fastener forward and raise the power-case clamp.

b. Position the ac power pack over the battery-well so that the connector is over the printed circuit fingers. Lower the ac power pack to mate the two parts of the power connector. Take care to align the parts before pressing down. If the connector is not fully seated, the next step in this procedure cannot be performed.

c. Lower the power-case clamp and clamp it down with the fastener. If the connector, in step b above, is not correctly mated, the power-case clamp cannot be fully lowered. In this case, remove the ac power pack and repeat step b. With the power-case clamp in the lowered position, connect the fastener by pressing the lower end into the mating portion and then pressing the upper end toward the case.

d. Connect the appropriate ac power cable to the ac power pack through the side of the carrying case of the VR-3000. The connector must be positioned so that the key mates with the keyway. Then press the connector toward the case and rotate the

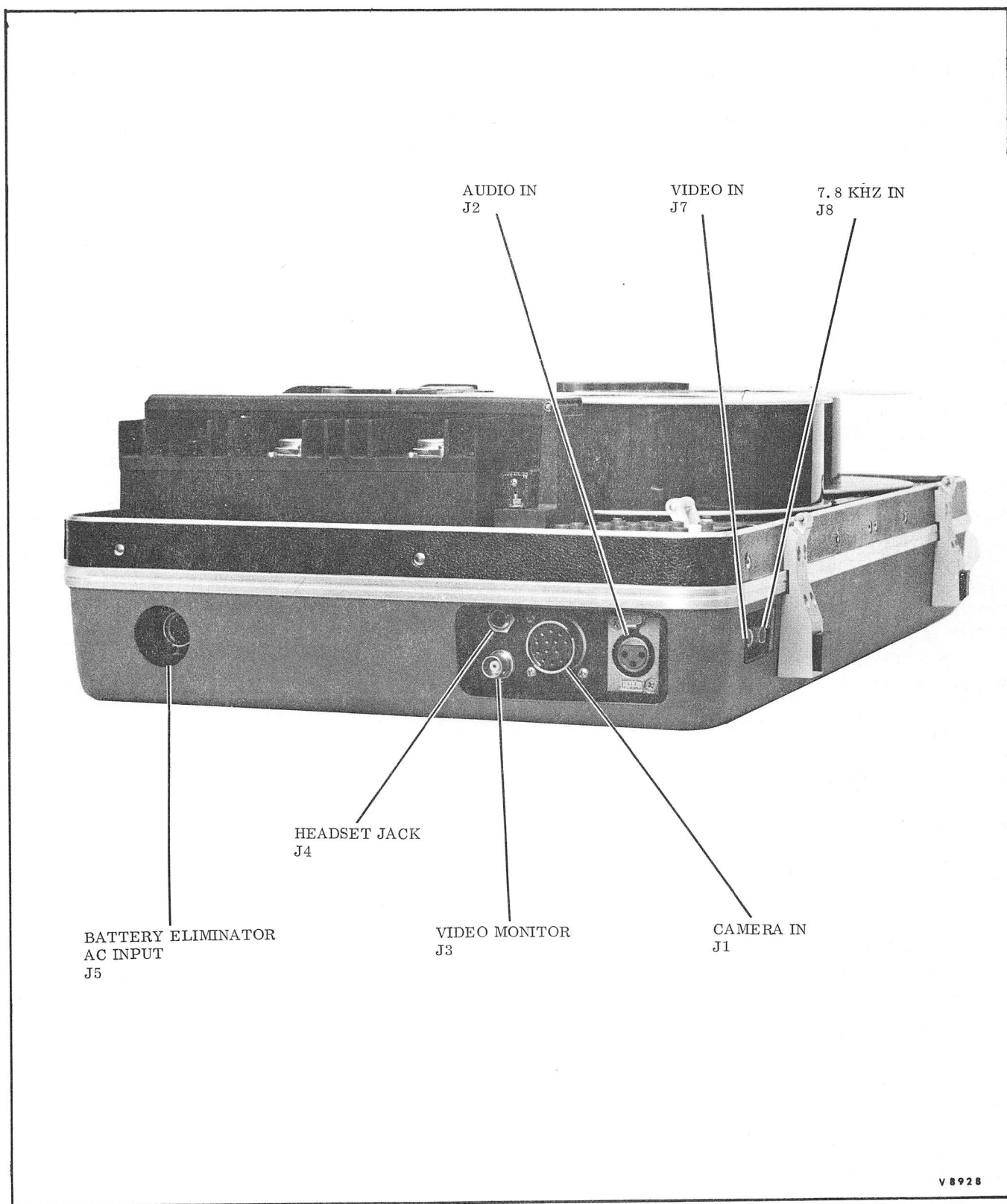


Figure 2-1. Locations of Signal and Power Connections on VR-3000 VTR

retaining ring until it mates with the key in the chassis receptacle. Press the connector into the receptacle and rotate the retaining ring until the detent is felt.

e. Plug the ac connector into the source of ac power and position the ON-OFF switch on the battery eliminator to the ON position.

2-10 **CONNECTING AUDIO SOURCE.** The source of audio is connected into receptacle J2. This is accomplished by pressing the connector straight into the receptacle until the shoulder of the connector seats against the face of the receptacle.

2-20 The audio source may consist of three types of audio signals as follows:

a. Balanced microphone input, 150/250 ohms, -50 to -60 vu. Because of the operation of the dual time constant, agc circuit, the microphone may be connected directly into the VR-3000 and audio level control left unmanned.

b. Balanced bridging line (no agc) input, 4,000 ohms, +8 vu nominal. This input requires an external amplifier (or console) manned by an engineer who is observing and correcting levels.

c. Balanced bridging line (agc) input, 4,000 ohms, -20 vu to +24 vu nominal. The agc circuits automatically maintain the peak amplitudes at 6 dB above +8 vu (standard playback level).

2-21 **CONNECTING VIDEO SOURCE.** The video input to the VR-3000 is at the camera receptacle J1 and the VIDEO INPUT receptacle J7. The camera receptacle provides connections for remote operating controls at the camera as well as the video signals. Input video levels are 0.5 volt peak-to-peak to 1.5 volt peak-to-peak, composite video. The level is adjustable through a front panel screwdriver adjustment, and may be monitored (100% white peaks) by the VIDEO LEVEL indicator.

2-22 When input video is supplied from another video source, the camera should be disconnected from the VR-3000. If it is necessary to monitor the input video, a video monitor may be supplied with video from the VR-3000 via connector J3. The output level at this point is 1 volt peak-to-peak, composite video, nominal impedance of 75 ohms.

2-23 PORTABLE OPERATION

2-24 Portable operation implies the use of the VR-3000 in a remote location, away from the conveniences of studio facilities. In this capacity, the VR-3000 may be positioned in a convenient location or "worn" on an alpine-type back-pack. To operate the VR-3000 as a self-contained video recorder, it is necessary to install a fully charged battery pack, connect a source of video, and connect a source of audio.

2-25 A headset connector is provided for a 2,000-ohm headset. Audio from the audio record amplifiers is present at the jack, J4, only during record ready mode, record mode and playback mode. In the record mode, the input audio being recorded is heard; during playback mode the playback audio is heard; and during record ready mode the audio channel may be used as an intercom.

2-26 The Ampex BC-300 camera is equipped with a viewfinder, which is used during record to view the input video to the VR-3000. During playback, the viewfinder is connected to the playback video output and serves as a monitor.

2-27 Input signal sources depend on the location and conditions of the recording session. Inputs are similar to the paragraphs above, describing the Fixed Operation.

2-28 **CHARGING BATTERY.** Battery charging procedures are described in Section IX.

2-29 CONNECTING BATTERY PACK

2-30 The battery pack is located at the right-hand side of the VR-3000. It is a

self-contained unit, with a connector at one end of the case. During operation, the battery pack is installed into the battery-well of the VR-3000 and clamped into place by the power-case clamp.

2-31 Use the following procedures to install the battery pack into the VR-3000:



MAKE SURE POWER SWITCH IS IN THE OFF POSITION BEFORE PROCEEDING WITH BATTERY INSTALLATION OR REMOVAL.

a. Loosen the fastener holding the power-case clamp. Pull the top of the fastener until it moves over-center, then lower the whole assembly until it clears the bottom wedge of the stationary part of the fastener. Pull the fastener forward and raise the power-case clamp.

b. Position the battery pack over the battery-well so that the connector is over the printed circuit fingers. Lower the battery pack to mate the two parts of the power connector. Take care to align the parts before pressing down. If the connector is not fully seated, the following step in this procedure cannot be performed.

c. Lower the power-case clamp and clamp it down with the fastener. If the connector, in step b above, is not correctly mated, the power-case clamp cannot be fully lowered. In this case, remove the battery pack and repeat step b. With the power-case clamp in the lowered position, connect the fastener by pressing the lower end into the mating portion and then pressing the upper end toward the case.

2-32 MOUNTING OF ALPINE-TYPE BACK-PACK. When it is necessary to operate the VR-3000 in a fully portable environment, the VTR may be mounted on an accessory back-pack and operated while being moved around. This is shown in Figure 2-2.

2-33 To mount the VR-3000 on the back-pack the following procedure is suggested:

a. Place the recorder, face down (the Ampex insignia should be away from the engineer), and position the back-pack assembly over it, so that the bottom of the alpine-type back-pack is over the bottom of the VR-3000. The bottom of the back-pack is the end near the hip harness.

b. Tighten the captive screws to secure the alpine pack to the fittings on the VR-3000 case.

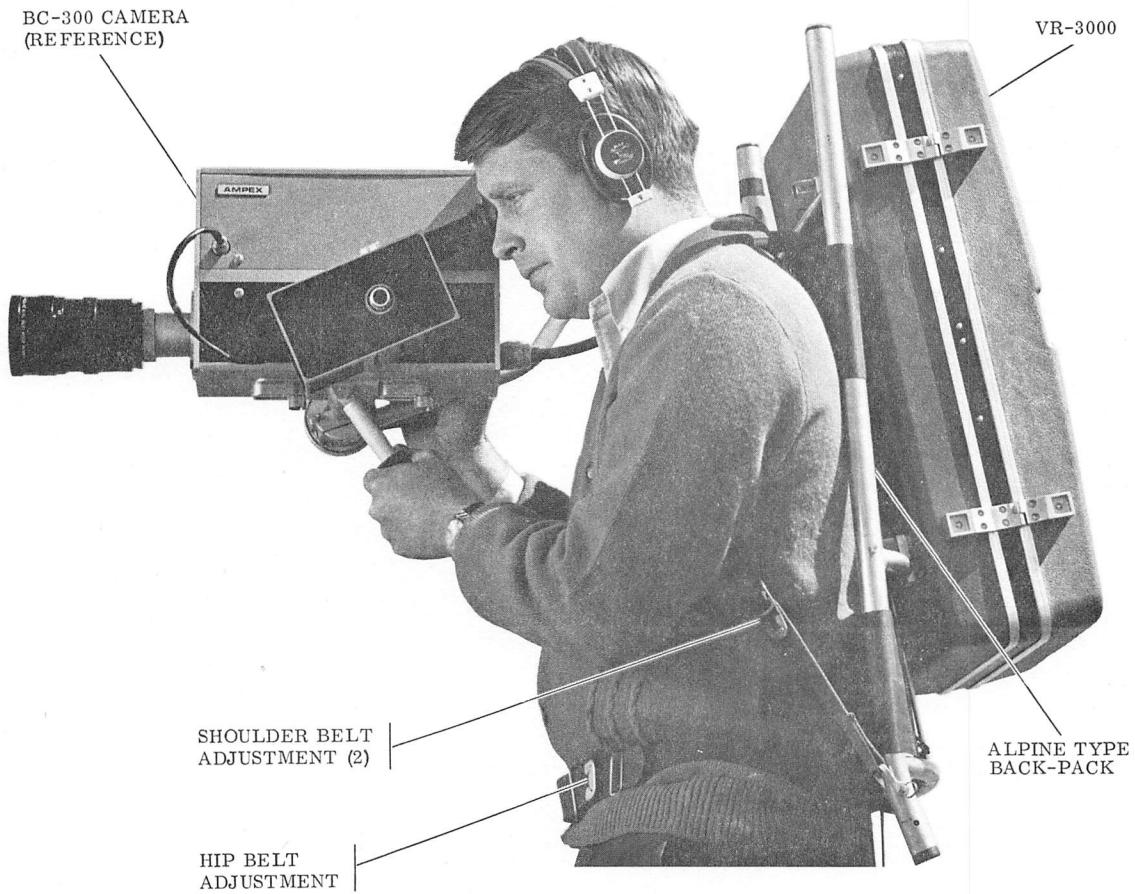
c. Installation of the VR-3000 on the back requires the services of a second man to hold the unit while it is being strapped on. Loosen the shoulder harnesses. Open the hip belt. Mount the back-pack, with the VR-3000, by placing the arms through the shoulder straps and pulling the assembly on like a vest. The second man should be holding the weight of the VR-3000 and back-pack away from the wearer.

d. Tighten the hip belt so that the weight of the unit is placed on the hip bones.

e. Tighten the shoulder straps just enough so that the back-pack is held against the body, but the weight of the VR-3000 is still predominantly on the hip bones (not on the shoulders).

f. Connect the video input and audio input to the respective connector.

2-34 VEHICULAR USE OF VR-3000. When the VR-3000 is used in or near an automotive vehicle or in an aircraft, the equipment may be powered by means of a dc to ac converter which is supplied with power from the electrical system of the vehicle. For this operation, the ac power pack (battery eliminator) is installed into the VR-3000 and uses the ac power from the converter.



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Figure 2-2. Portable Operation Using Alpine-Type Back-Pack

NOTE

The dc-ac converter is not supplied by Ampex. The converter used with a VR-3000 must provide 115 or 220-volt ac power at frequencies between 50 Hz and 400 Hz. The unit selected must be capable of at least 150 watts continuous duty.

The ac power pack can then be connected to the ac. Also, the battery charger may be used at the same time to keep a charged battery available, in case it becomes necessary to operate the video recorder away from the vehicle. It should be noted that the ampere hour capacity of a vehicular electrical system is greater than that of the silicad batteries.

SECTION III

OPERATION

3-1 SCOPE

3-2 This section contains the description of all operating controls and indicators on the VR-3000 VTR. A description of the battery charger controls is included and the meanings of the lighted indicators are discussed. Pre-operational procedures to test the videotape recorder after receipt and a familiarization procedure are included to familiarize a new operator with the video tape recorder.

3-3 OPERATING CONTROLS AND INDICATORS

3-4 VR-3000. The locations of operating controls and indicators on the VR-3000 are shown in Figure 3-1. Refer to Table 3-1 for a listing of the controls and indicators of the VR-3000.

3-5 BATTERY CHARGER. The locations of operating controls and indicators on the battery eliminator are shown in Figure 3-2. Table 3-2 is a listing of the controls and indicators shown in Figure 3-2.

Table 3-1. VR-3000, Operating Controls and Indicators

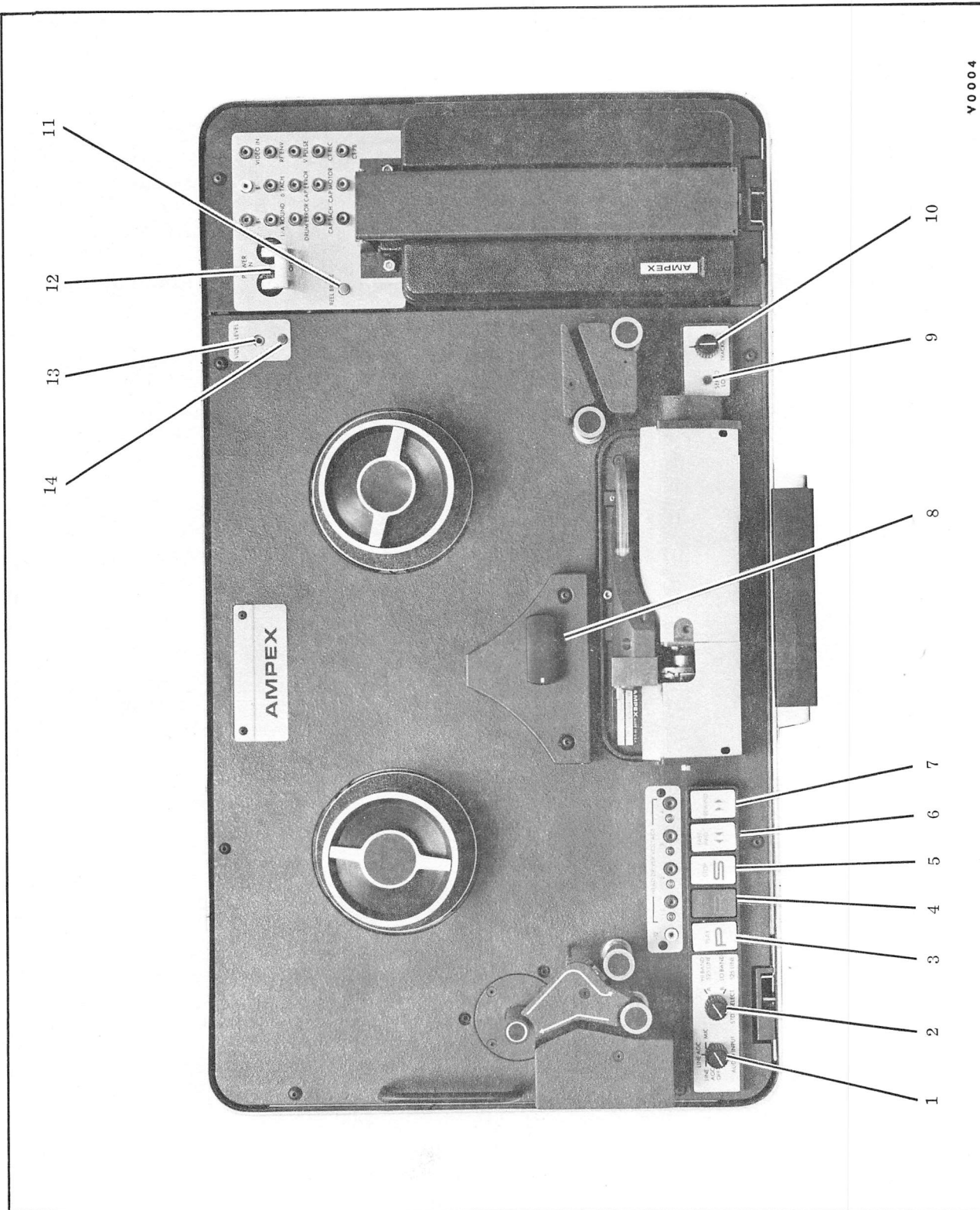
Index No.	Control or Indicator	Function
1	AUDIO INPUT switch	A three position, rotary switch which is used to select the input level, and agc characteristics of the audio section. When rotated from ccw, toward cw, the following functions are selected: 1 - LINE input, agc off 2 - LINE input, agc on 3 - MICROPHONE input, agc on
2	STD SELECT switch	A two position, rotary switch which is used to select the television line standard to be used. The available line standards are listed in Table 5-1 in terms of switch positions A or B.
3	VIDEO LEVEL indicator	An amber indicator lamp that flickers when the video level adjustment is adjusted for correct fm deviation.

Table 3-1. VR-3000, Operating Controls and Indicators (Continued)

Index No.	Control or Indicator	Function
3	VIDEO LEVEL indicator (cont.)	NOTE For this indicator to work properly, 100% white level must be present in the video input. This indicator does not respond to color sub-carrier.
4	VIDEO LEVEL adjustment	A screwdriver type adjustment, used to adjust the fm deviation of the modulator to have the indicator (item 3) above just flicker on 100% white peaks.
5	POWER switch	A circuit breaker that applies dc power to the VR-3000 and associated camera.
6	REEL BRAKE indicator	A red colored indicator lamp that lights whenever the supply and takeup reels are locked by the mechanical brake control (item 9)
7	TRACKING control	This potentiometer controls the head-to-track, relative position. In the center of its range, the heads traverse the home track.
8	SERVO LOCK indicator	A green lamp that lights during the record mode, only when the head drum servo is phase locked to the incoming video signal.
9	Mechanical brake control	Operation of this knob, by rotating it clockwise, causes a mechanical brake to extend outward making contact with the supply and takeup reels. The REEL BRAKE indicator (item 6) lights when the mechanical brake control lever is not fully ccw, indicating that the brakes are not fully withdrawn. Unless this control is fully ccw, the VR-3000 is forced into the Stop Mode (see the description associated with item 12).
10	REWIND switch	A momentary pushbutton switch that places the tape transport in the rewind mode. If the tape is rewinding slowly, when the rewind mode is first started, release of the

Table 3-1. VR-3000, Operating Controls and Indicators (Continued)

Index No.	Control or Indicator	Function
10	REWIND switch (cont)	REWIND button stops the rewind mode; once the supply and takeup reels gather speed, the rewind operation is maintained after release of the REWIND button. Termination of the rewind mode must then be performed by pressing the STOP button.
11	FAST FWD switch	A momentary pushbutton switch that places the tape transport in the fast forward mode. The tape begins to move forward at twice the record or playback speed; the tape is held in the vacuum guide which is in its retracted position, away from the rotary heads. Release of this button stops the fast forward mode.
12	STOP switch	A momentary pushbutton switch that deactivates the VR-3000 and places it in a stand-by state ready to start operation when one of the other control pushbuttons is pressed.
13	RECORD READY switch	A momentary pushbutton switch that places the servo circuits into operation. Specifically, the head drum is brought up to speed and phase-locked, in anticipation of a record mode operation. The record mode is selected by simultaneously pressing the RECORD READY and PLAY pushbuttons. The record mode is initiated after a delay of approximately 1/2 second. If a record mode operation is attempted on a previously recorded tape, the record mode will be held off until the VR-3000 senses a blank tape. This is done by checking for the absence of the control track.
14	PLAY switch	A momentary pushbutton switch that places the VR-3000 in the play mode. The playback video circuits are energized.



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Figure 3-1. VR-3000 VTR Operating Controls and Indicators

Table 3-2. Battery Charger, Operating Controls and Indicators

Index No. (Figure 3-2)	Control or Indicator	Function
1	RESET circuit breaker	This control is the reset button for a 1 ampere circuit breaker. When released, the button is extended outward from the battery charger front panel. To reset the breaker, just press in on the button.
2	ON-OFF power switch	A toggle switch controlling the input, ac power.
3	Meter Select switch	A 21 position switch which is used to select an individual battery from either battery pack #1 or battery pack #2 for connection to the meter. Polarity is automatically switched so that the meter always reads up-scale. Position number 11 of this switch is OFF.
4	SHORTED indicator	A red colored indicator lamp that lights when a shorted cell occurs in a battery pack, plugged into Battery #1 connector (item 7).
5	CHARGED indicator	A green colored indicator lamp that lights when the first battery from the battery pack, which is plugged into Battery #1 connector, becomes fully charged.
6	Meter	A dual scale voltmeter used to measure the voltage of the individual batteries comprising the battery packs. This is controlled by the selection switch (item 3).
7	Battery #1 connector	This connector is used to mate the battery charger with a battery.
8	Battery #2 connector	This connector is used to mate the battery charger with a battery.
9	CHARGED indicator	A green colored indicator lamp that lights when the first battery from the battery pack which is plugged into battery #2 connector becomes fully charged.

Table 3-2. Battery Charger, Operating Controls and Indicators (Continued)

Index No. (Figure 3-2)	Control or Indicator	Function
10	SHORTED indicator	A red colored indicator lamp that lights when a shorted cell occurs in a battery pack which is plugged into Battery #2 connector (item 8).
11	PUSH FOR EXPANDED SCALE switch	This momentary action, pushbutton switch selects the up-scale starting voltage and meter sensitivity for the voltmeter (item 6). In its released position, the voltmeter reads from 0 volts to 5 volts. When pressed the meter reads from 4.55 volts to 4.75 volts.  CAUTION THIS SWITCH MUST NOT BE PRESSED TO TEST BATTERY VOLTAGES WHEN THE AC POWER TO THE BATTERY CHARGER IS TURNED OFF.

3-6 FAMILIARIZATION AND CHECK-OUT PROCEDURES

3-7 The purpose of this procedure is to acquaint a new user with the VR-3000 recorder, and to ensure that the recorder has sustained no damage during shipping. Also, a pre-operational procedure is included so that prior to actual operation of the recorder, each time it is used, certain checks are performed to serve as a confidence test, to ensure that the system is operating satisfactorily and that all controls accessible from the front panel are adjusted to their optimum position.

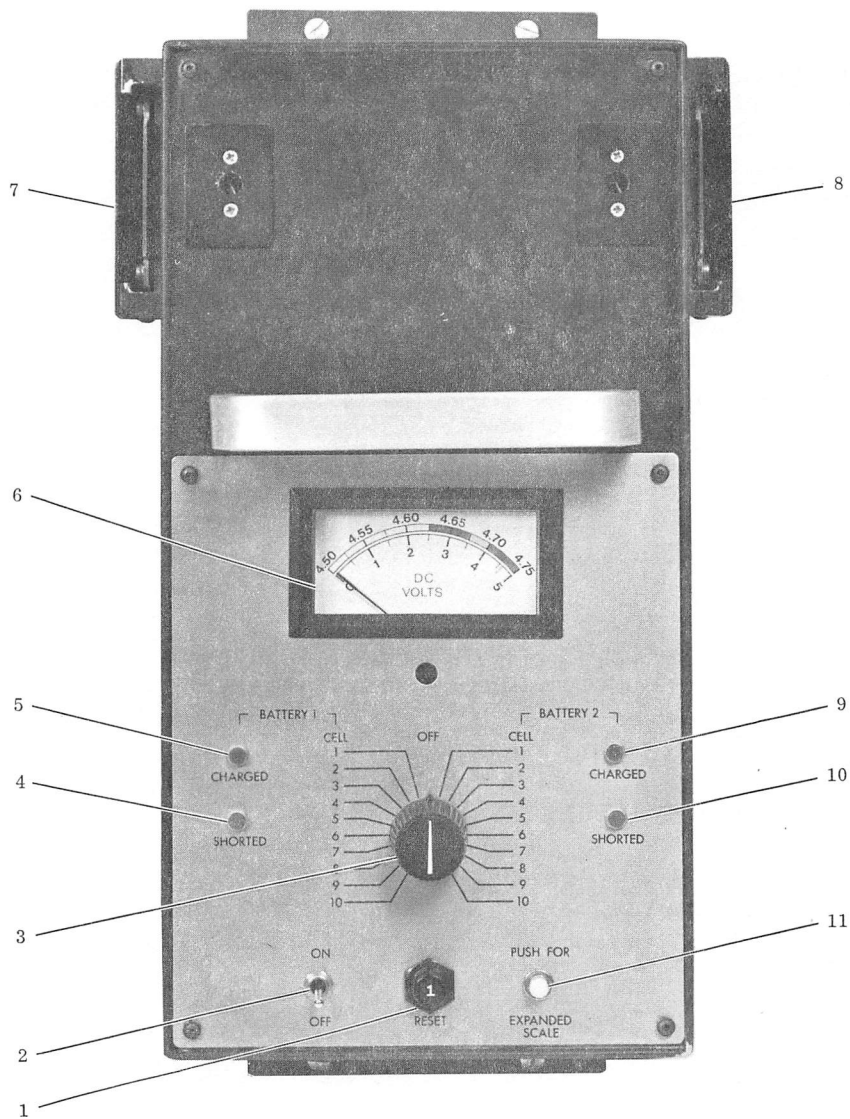
3-8 FAMILIARIZATION

3-9 After the VR-3000 VTR has been installed and the user has become familiar with the location and function of the controls, as described above in Tables 3-1 and 3-2,

the following procedures should be performed. In addition to the function of familiarizing the user with the operation of the recorder, the successful completion of this procedure indicates that the recorder is operating properly.

1. Check that the batteries are fully charged and the battery charger is operational. This procedure is described in Section IX procedures concerning the charging of exhausted batteries.

2. Check that the POWER switch is in the OFF position. Place a charged battery into the VR-3000 VTR. Be careful to mate the connector on the VR-3000 with the connector on the battery. Careless insertion of the battery may cause breakage of this connector. Lower the power case clamp over the battery and clamp it down.



V8926

Figure 3-2. VR-3000 Battery Charger Operating Controls and Indicators

3. Using a 20,000 ohm-per-volt meter, insert the test leads into the B+ and B- terminals on the test point panel (TPP). Set the range switch of the meter to measure 32 volts. Switch the power switch to the ON position. A short circuit will cause the circuit breaker (POWER switch) to trip.

4. Check for the presence of approximately 32 volts between the B+ and B- terminals on the test point panel. Check that the voltages between B+ and ground, and B- and ground are approximately equal (to within one volt). Any large discrepancies in voltage reading, using a charged battery pack, indicate trouble in the battery circuit of the VR-3000. If this condition is encountered, immediately switch the POWER switch to OFF and remove the battery. Determine the cause of the fault before connecting power to the VR-3000.

5. Turn off the dc power by switching the POWER switch to the OFF position.

This verifies the presence of battery voltage within the VR-3000 and the absence of shorts associated with the battery voltage input.

6. Connect a source of composite video, preferably a test pattern, containing 100% saturated white components, to connector J7 (VIDEO IN). This signal should have a nominal peak-to-peak amplitude of 1 volt. If a non-standard amplitude video signal with a peak-to-peak amplitude from 0.5 volt to 1.5 is available, it may be used, but the VIDEO LEVEL control must be adjusted (Step 14).

7. Connect a video monitor to J3 on the VR-3000. This monitor must be terminated in 75 ohms.

8. Connect a source of audio, at 1,000 Hz, +8 vu, 600 ohms, to the AUDIO IN jack J2.

9. Connect a headset to the HEADSET JACK J4.

10. Turn on the monitor. Place the POWER switch on the VR-3000 to the ON position. Observe that the input video appears on the monitor and the takeup turntable begins to rotate counterclockwise. The supply turntable should resist being turned manually (automatic application of brake).

11. Turn the mechanical brake control clockwise (Figure 3-1, item 9). Observe that the REEL BRAKE indicator (Figure 3-1, item 6) lights. Rotate the mechanical brake control fully counterclockwise. Observe that the REEL BRAKE indicator light extinguishes.

12. Listen in the headset for presence of the 1,000 Hz audio signal.

13. Press the RECORD READY button on the controls panel. Observe that the head drum starts rotating and the tape vacuum guide advances and withdraws once. Press the STOP button. Observe that the drum stops rotating.

14. Observe the VIDEO LEVEL indicator (Figure 3-1, item 3). The light should be barely flickering. If the light is either fully on or fully off, adjust the VIDEO LEVEL potentiometer (screwdriver adjustment) so that the light just barely flickers (Figure 3-1, item 4).

15. Switch off the power by operating the POWER switch to the OFF position.

3-10 This completes the preliminary setup. It is now necessary to thread a tape through the tape transport and verify the record and playback operations.

3-11 TAPE LOADING. Tape loading consists of installing a reel of bulk-degaussed tape on the supply turntable, installing an empty reel on the takeup turntable, and threading the tape through the tape transport. The procedure for tape loading is as follows:

1. Remove power from the VR-3000 and, if necessary, release the mechanical brake from the supply and takeup reels.

2. Place a reel of tape on the supply reel turntable, and turn the reel hold-down handle in a clockwise direction to secure the reel to the turntable.

NOTE

It may be necessary to turn the reel hold-down handle in a counterclockwise direction to place a reel on either the supply or takeup reel turntables. (Do not force the reel onto the reel turntable.)

3. Place an empty reel on the take-up turntable, and turn the reel hold-down

handle in a clockwise direction to secure the reel to the turntable.

4. Pull approximately two feet of tape from the supply reel and thread the tape through the tape transport as shown in Figure 3-3.

5. When threading is completed, place a finger through the slot of the takeup reel and hold the tape against the hub. Turn the takeup reel in a counterclockwise direction until the tape end is securely fastened by a layer of tape over it.

6. Determine that the lower edge of the tape is seated against the shoulder at the lower end of the vacuum tape guide.

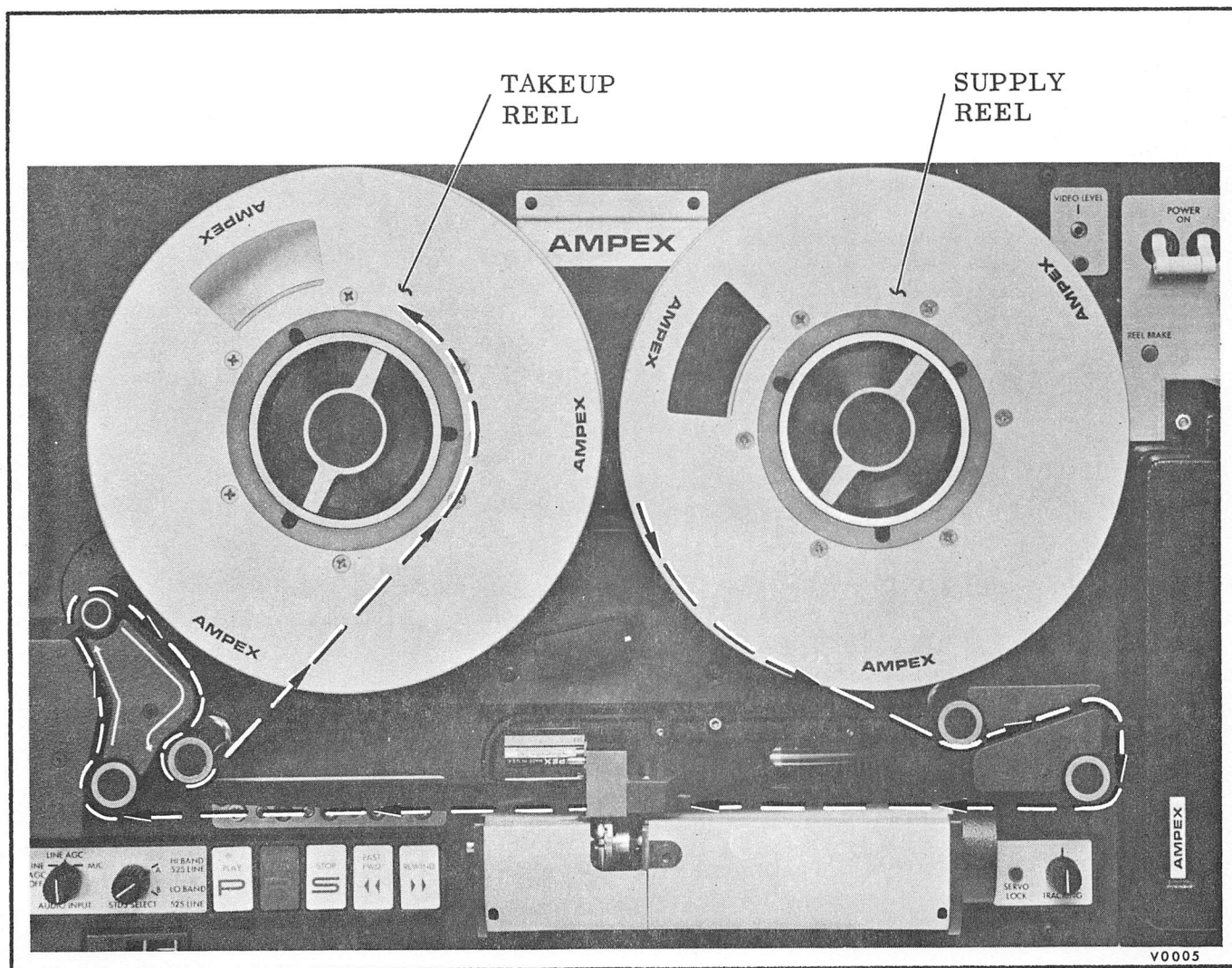


Figure 3-3. Tape Threading Path in VR-3000 VTR

7. Turn the takeup reel in the counter-clockwise direction until all tape slack is removed and both tape tension arms swing away from their rest position.

8. Press the FAST FORWARD button for approximately four seconds so that the takeup reel rotates for several revolutions to wind several turns of tape. This is to prevent slippage at the beginning of a recording.

3-12 CHECKOUT PROCEDURES

3-13 Once the preliminary setup is performed and the tape is threaded, the operational modes of the VR-3000 may be verified by performing the following procedures.

3-14 Fast Forward

1. Apply power to the VR-3000 by operating the POWER circuit breaker to ON.

2. Press and hold the FAST FORWARD button. Observe that the tape guide advances and withdraws, the vacuum pump starts, the head drum starts rotating, and tape starts moving in the forward direction.

3. Release the FAST FORWARD button. Observe that the forward motion of the tape ceases and the head drum rotation stops. The vacuum pump should continue running for an additional 5 seconds (approximately).

3-15 Record Ready

1. Press the RECORD READY button. Observe that the tape guide advances and then retracts, the vacuum pump motor starts, and the head drum starts rotating, and continues. The audio channel is now active and the 1,000 Hz signal at J2 is present at the headset.

2. Press the STOP button.

3-16 Record

1. Press the RECORD READY button and allow the head drum to come up to speed.

2. Set the STD SELECT switch to the required band.

3. Set the AUDIO INPUT switch to the correct position.

4. Press the RECORD READY button simultaneously with the PLAY button. Observe that the tape guide advances the tape against the rotating heads. The tape should begin moving in a forward direction. If a freshly degaussed tape is being used, the SERVO LOCK indicator (Figure 3-1, item 8) should light within five seconds. If a previously recorded tape is used and there is a recorded control track present, the record mode is delayed until the VR-3000 senses the absence of a control track (starts recording only on a clear section of tape).

It is necessary to first start the VR-3000 operating in the record ready mode, so that the head may be brought up to speed and synchronized with the incoming video signal, before the record mode is initiated. If for some reason the record mode is started when the VR-3000 is completely stopped (stop mode), it is necessary to wait for eight seconds for the head to come up to speed and to lock with the incoming video. During this run-up time, the tape is being advanced, and thus the first eight seconds of tape are unusable.

5. To stop the record operation, press the STOP button. Observe that the tape guide withdraws, approximately 15 inches of tape are automatically rewound, the drum stops rotating, and the vacuum pump continues to operate for approximately 5 seconds.

6. Rewind the tape as described below, to the start of the recorded section of tape.

3-17 Rewind

1. Repeat step 1 of the fast forward procedure, above.

2. Press and quickly release the REWIND button. Observe that the tape guide

advances and withdraws, the vacuum pump starts, the head drum begins to rotate and tape motion starts in the reverse direction. All of the operations should cease when the button is released except for the operation of the vacuum pump which remains energized for an additional period of approximately 5 seconds.

3. Press and hold the REWIND button until the tape rewind motion is at full speed, then release the button. All of the operations described in step 2, above, should occur again, but release of the REWIND button should not terminate the operation.

4. Press the STOP button. Observe that the rewind operation now stops. All operations should cease with exception of the vacuum pump which should remain in operation for an additional period of approximately 5 seconds.

3-18 Play

1. Press the PLAY button. Observe that the tape guide advances, the vacuum pump starts, the tape begins to move forward, and the head drum is rotating.

2. Observe the recorded video being played back on the monitor. If necessary, adjust the TRACKING control (Figure 3-1, item 7).

3. Listen in the headset and verify that the recorded audio is present.

4. Press the STOP button. Observe that the tape guide is withdrawn and the head drum stops. The same automatic rewind operation of 15 inches of tape is performed as in the Record Mode.

3-19 This completes the checkout procedures. It should be noted that the setting of the VIDEO LEVEL screwdriver adjustment potentiometer is intended for non-standard

amplitude video. This adjustment allows for correct fm deviation from input video signals with amplitudes varying from 0.5 volts peak-to-peak to 1.5 volts peak-to-peak. This adjustment is described in Section IX of this manual under the heading of Preventative Maintenance.

3-20 OPERATING PROCEDURES

3-21 The VR-3000 may be operated from a self contained battery or an ac powered battery eliminator. Input video may be either from a portable camera or a studio line, as long as the peak-to-peak amplitude is nominally 1 volt. Audio input may consist of a microphone or a high level line; the setting of AUDIO INPUT switch determines the audio circuit sensitivity.



WHEN USING THE BATTERY PACK WITH THE VR-3000 VTR, DO NOT CONNECT ACCESSORY LOADS (SUCH AS PORTABLE LAMPS, MONITORS, ETC.) OTHER THAN THE HAND-HELD CAMERA TO THE BATTERY PACK. TO DO SO MAY DAMAGE THE BATTERY PACK OR SHORTEN ITS LIFE.

3-22 INITIAL TURN-ON

3-23 To apply power to the VR-3000 VTR and associated camera (if being used), place the POWER circuit breaker to the ON position. (If the battery eliminator is being used, make sure that the ON-OFF switch is in the ON position and the circuit breaker is pushed in.) The BRAKE REEL indicator lamp will be lit if the supply and takeup reels are locked by the mechanical brake. If the BRAKE REEL indicator lamp is lit, release the mechanical brake.

NOTE

The audio circuits within the VR-3000 VTR are immediately operative when the POWER circuit breaker is placed in the ON position. (In addition, the take-up reel supplies a slight torque in the forward direction to maintain a taut tape path.) Thus, when using the recorder with the Ampex Model BC-300 camera in the hand-held-camera-back-pack-recorder configuration, the operator can receive instructions, etc., (via his headset which plugs into the recorder) before recording.

3-24 RECORD READY MODE

3-25 To place the VR-3000 VTR in the record-ready mode, press the RECORD READY pushbutton on the unit. Observe that the head drum is rotating, and that the vacuum pump is operating. Before initiating the record mode, determine that the STDS SELECT and AUDIO INPUT switches are in the correct position. In addition, if necessary, adjust the VIDEO LEVEL screwdriver control until its associated indicator lamp barely goes on (or may flicker). To ensure that the control track starts recording in the proper phase, set the TRACKING control to line up with the mark on the chassis (home track position).

NOTE

When recording a color signal, 100% white (a few microseconds) must be present in the input signal for proper adjustment of the VIDEO LEVEL screwdriver control. The level sensor is insensitive to the chrominance component.

3-26 RECORD MODE

3-27 To place the VR-3000 VTR in the record mode, simultaneously press the RECORD READY and PLAY pushbuttons on the unit. Observe that the SERVO LOCK indicator lamp is lit. (If a remote camera such as the Ampex BC-300 camera is being used, the on-the-air indicators on the camera will also be lit.) When finished recording, press the STOP pushbutton. Observe that the recorder automatically rewinds about 15 inches of tape.

3-28 PLAYBACK MODE

3-29 Before initiating the playback mode, press the REWIND pushbutton on the unit and rewind the tape, as required, until the segment of tape desired for playback is obtained; then press the STOP pushbutton.

NOTE

When rewinding large lengths of tape, it may be convenient to remove the tape from the tape path and allow it to rewind directly reel-to-reel. This will bypass the capstan and allow a quicker rewind operation.

(Also use the FAST FORWARD pushbutton, if necessary, to obtain the desired starting point for playback.) Initiate the playback mode by pressing the PLAY pushbutton. If a picture monitor is being used with the recorder (e.g., the viewfinder on the remote camera), adjust the TRACKING control on the VR-3000 for optimum presentation of the recorded signal on the picture monitor. Press the STOP pushbutton to terminate the playback mode.

3-30 EQUIPMENT TURN-OFF

3-31 To remove power from the VR-3000 and associated camera (if being used), place the POWER circuit breaker to the OFF position.

SECTION IV

SYSTEM THEORY AND TAPE TRANSPORT THEORY

4-1 GENERAL

4-2 This section describes the system theory of operation, including the overall operations of the tape transport, servo systems tape format including locations of tracks, video recording method with rotary heads, audio recording method, video head assembly operation and audio head assembly. Referenced in this section and in all following sections, the parenthetical numbers represent operation of the VR-3000 using one of the 50-field line standard systems.

4-3 OVERALL THEORY OF OPERATION

4-4 RECORDED SIGNALS

4-5 The signals recorded on the two-inch magnetic tape used in the VR-3000 include a control track signal, video track signal, and an audio track signal. Figure 4-1 shows a typical section of tape, including all of these signals; the track width allotted to each type of signal and the relationship between the tracks is exaggerated for clarification.

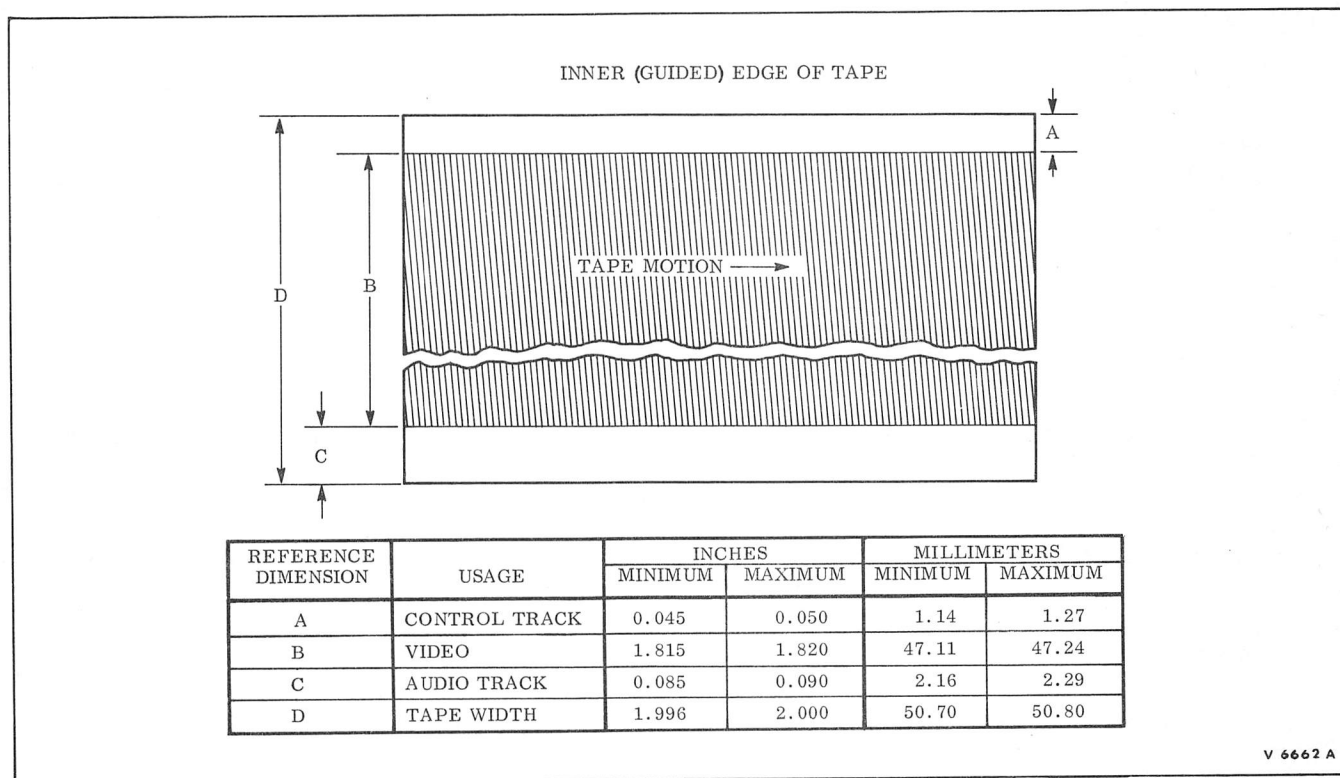


Figure 4-1. Tape Track Location

4-6 ROTARY HEAD RECORDING

4-7 The bandwidth required for satisfactory recording of a color video signal calls for tape speeds over 1,000 inches-per-second (ips). This should mean that a minute of recorded video would require almost a mile of tape.

4-8 Rather than moving magnetic tape past a fixed head, the rotary head recording system moves both the tape and head. In the VR-3000, tape is moved past the head at a linear rate of 15 inches-per-second (ips). The video head itself, however, is rotating at 240 revolutions-per-second (rps) for 60-field line standards, or 250 rps for 50-field line standards.

4-9 There are four video heads, mounted exactly 90 degrees apart on a video head drum; each head passes across the tape once for each revolution of the head drum. At a forward speed of 15 ips, and a rotational drum speed of 240 rps, the head-to-tape velocity is approximately 1500 ips.

4-10 The width of the recorded video track is equal to the width of the video head tip on the head drum. The Mark XI used on the VR-3000 uses the standard (15 ips) head tip width of 10 mils. Consequently, center-to-center track spacing is 15.6 mils and the guard band is 5.6 mils. Under the 525-line, and 625-line standards each pass of a head across the tape records 16 or 17 lines of video. The 525 lines that constitute a complete frame are contained in 32 successive parallel tracks that occupy a total of one-half inch (12.7 millimeters) of tape length; the vertical synchronizing interval always occurs in the center of a video track (produced by head #4).

4-11 Figure 4-2 shows the relationship between the recorded video tracks, the placement of the vertical blanking interval, and the control track signal. The control track signal is recorded by the control track head, located at a predetermined distance away from the video head drum. The control track indicates the instantaneous position of the

head drum as a function of the 240 (or 250) Hz sine wave phase. In addition, a frame pulse at the beginning of each new frame of video is recorded on the control track.

4-12 VIDEO RECORDING

4-13 Video information is recorded in the form of a variable-frequency carrier (fm). The modulator used in the VR-3000 VTR is basically a voltage controlled multi-vibrator; the output frequency of the modulator is a direct function of the input voltage.

4-14 The format of the video signal used (i.e., the peak-to-peak video level and the ratio of sync amplitude, burst amplitude, and pedestal or blanking level to peak-to-peak video level or to each other) is established by the FCC or CCIR; the VR-3000 VTR modulator should be supplied with a signal having the correct peak-to-peak amplitude. This is accomplished by connecting a video signal with amplitude of 0.5 to 1.5 (nominally 1 volt p-p) peak-to-peak, to the input of the VR-3000 VTR. No video erase head is included in the VR-3000. This introduces the requirement for use of bulk degaussed tape. If a control track is present on the tape when the record mode is initiated, the VR-3000 will not switch to record.

4-15 AUDIO RECORDING

4-16 The method of recording audio is identical to that used in any high-quality audio recorder; tape (in this case, a portion of the two inch tape) is moved past the fixed audio head, and the signal is recorded together with high-frequency bias. Because the VR-3000 is designed to conserve power, no audio erase head is included. An erase head is normally used to clear a 90 mil wide path, through the video tracks, for the audio track. The standard audio track is 70 mils leaving a guard band of 70 mils. Because of the exclusion of the erase head from the VR-3000, the bias in the audio head (the audio head used in the VR-3000 is 90 mils wide) is used to provide some erasure while recording. This leaves a 90 mil audio track.

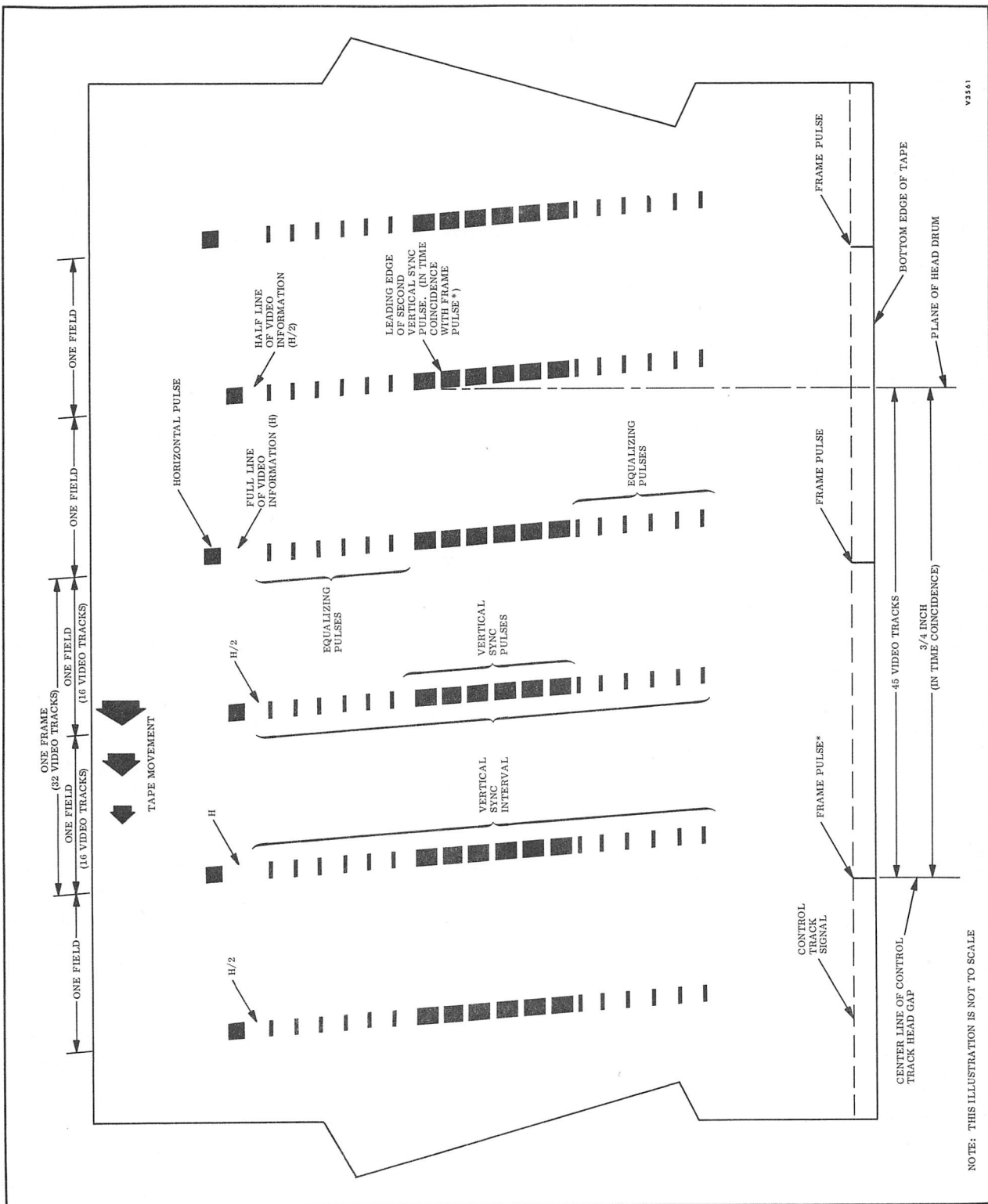


Figure 4-2. Video Track Spacing

4-17 SERVO SYSTEM

4-18 The capstan, head drum, supply reel, and take-up reel motion are controlled by servo systems. This ensures that recorded video stability is tightly controlled, even during adverse environmental conditions. The input video is recorded with a comparable stability to that of a studio-console recorder.

4-19 The VR-3000 is intended primarily as a portable video recorder and in this capacity may be used mounted on an alpine-type back-pack, worn by the recording engineer. This form of operation introduces angular accelerations. The servo systems are designed to compensate for these externally introduced forces, which would otherwise change tape speed.

4-20 A tachometer pickup on the drum motor shaft feeds two pulse signals back to the servo system. One of these signals occurs once for each drum revolution; the other signal occurs six times for each drum revolution. The instantaneous frequency of these signals is representative of the instantaneous rotational speed of the head drum. The occurrence of the once-around pulse is representative of a reference position in the rotational phase of the head drum. This "once-around" pulse is also used to generate a square wave-signal which after smoothing, is recorded as the sine wave control track signal on the tape.

4-21 During record the capstan speed is held within close tolerances so that tape speed is precisely controlled at 15 ips (for the 60-field standard). During playback, the speed of the capstan becomes a function of the control track signal. Similarly, during record, head drum speed and phase is precisely controlled by the head drum servo using, in part, the vertical sync information. Operation of the servos is described in Section VI.

4-22 TAPE TRANSPORT THEORY OF OPERATION

4-23 The tape transport is located on the top panel of the VR-3000, together with the operating controls, the test point panel, and the battery holder. The tape transport components are illustrated in cut-away view shown in Figure 4-3. The head drum, tape guide, and control track head are all part of the Mark XI head assembly.

4-24 The principal units of the tape transport include:

- a. Vacuum system
- b. Capstan assembly
- c. Supply reel assembly
- d. Take-up reel assembly
- e. Compliance arms including strain gauges
- f. Mark XI head assembly
- g. Audio head assembly

4-25 The purpose of the tape transport is to move the two inch magnetic tape at a speed of 15 inches-per-second during record or playback, and to move the tape at a higher speed during fast forward and rewind. The video and audio heads do not contribute to the movement of tape. However, as they are mounted on the tape transport, the head assemblies themselves will be described below.

4-26 CAPSTAN ASSEMBLY

4-27 The capstan assembly includes a dc motor, tachometer, and rubber coated capstan. Input power for the capstan motor consists of a controlled dc voltage. The capstan motor may be rotated in either direction, depending on the required operation. Capstan speed control is performed by controlling the voltage applied to the motor winding.

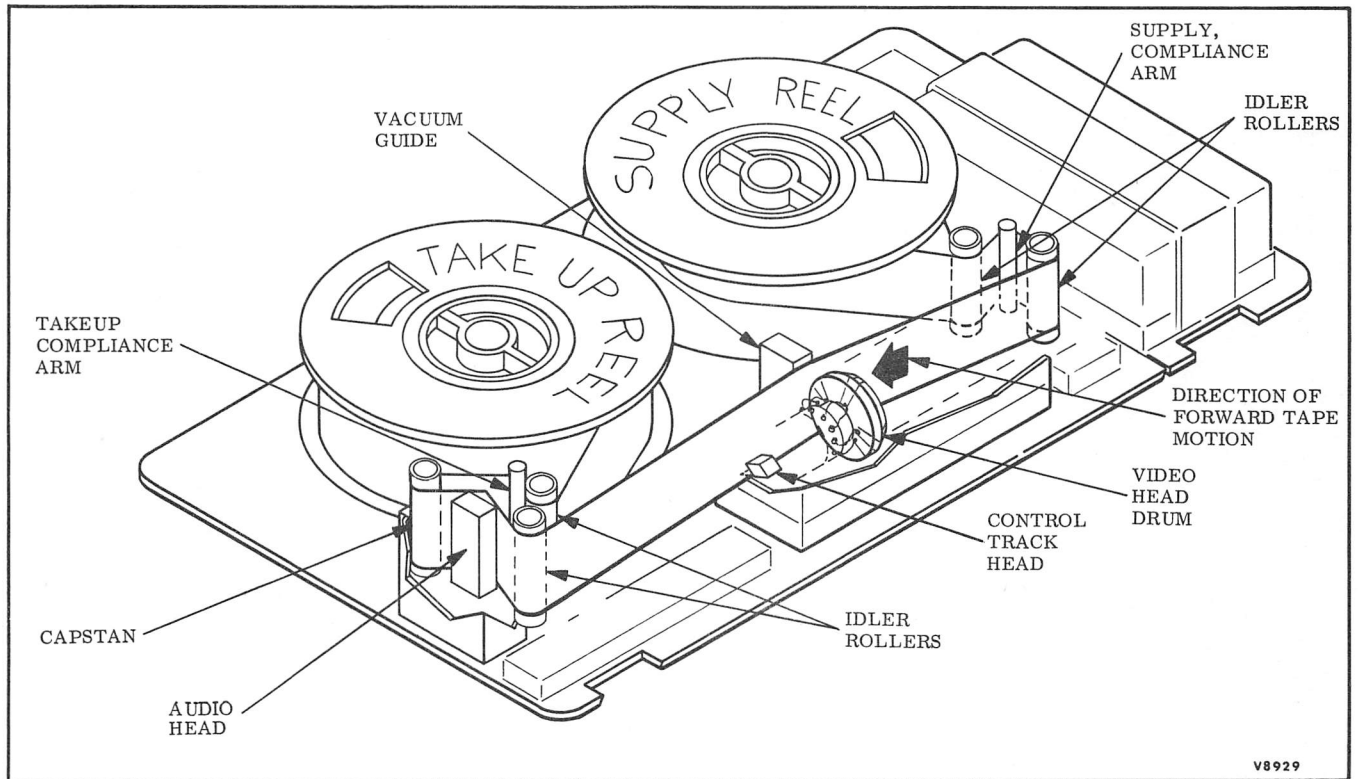


Figure 4-3. Tape Transport

4-28 The tachometer and capstan are directly connected to the motor shaft. The tachometer consists of two transparent discs, each containing 1024 opaque wedges which extended from the center toward the perimeter. One of the discs is attached to the capstan shaft and rotates with the capstan. The second disc is fixed to the capstan housing and is held stationary with respect to the shaft rotation. As the capstan shaft begins to rotate, the light transmission path through the two discs is alternately semi-transparent and opaque. Tachometer pick-up is derived from two sets of light sources and associated photo diodes.

4-29 The capstan is a precision machined cylinder, mounted on the capstan motor shaft, and is coated with rubber to increase its coefficient of friction. No capstan idler (pinch roller) is used in the VR-3000 tape transport. Instead, the tape path is designed to have a large wrap angle around the capstan. The capstan does a minimum

amount of work; the work needed to move the tape at 15 ips is produced by the take-up reel motor. The amount of wrap is sufficient for capstan control.

4-30 VACUUM SYSTEM

4-31 A low volume vacuum pump is located under the tape transport and is used to hold the recording tape against the concave surface of the female tape guide. Any time that the tape or head drum motion begins the vacuum pump is turned on and the tape guide is brought forward so that the tape is forced against the guide and is "captured" by the vacuum. The operation of advancing the guide to capture the tape is necessary because the vacuum pump has insufficient volume to attract the tape from afar. Any time the tape is moved with respect to the head drum, the head drum is rotated and the tape is held in the guide, preventing longitudinal scratching of the tape by otherwise stationary head tips.

4-32 SUPPLY REEL ASSEMBLY

4-33 The supply reel assembly includes a reel hold-down assembly, a rewind motor and a magnetic particle brake. The hold-down assembly consists of an expanding serrated ring, positioned between an upper and lower cone. As the two cones are pressed together, by rotating the hold-down knob clockwise with respect to the reel turntable, the ring expands and presses the inside of the tape reel hub, clamping it.

4-34 The supply reel motor is a permanent magnetic, dc motor used only during rewind operations.

4-35 The magnetic particle brake consists of a powdered magnetic material located between moving and stationary parts of the magnetic brake. A field coil is wound around the assembly so that magnetic fields produced by current in the coil, influences the particles, causing the powdered magnetic material to form into a plastic mass, having the characteristics of a variable mechanical resistance. Relative motion between the moving parts of the brake and the stationary parts of the brake is thus resisted by the magnetized particles. The degree of motion resistance is a direct function of the current through the coil.

4-36 TAKE-UP REEL ASSEMBLY

4-37 The reel turntable is similar to the supply reel turntable. A permanent magnetic dc motor is used to provide the torque needed to produce the force to drive the tape at 15 ips, during record or playback modes. The same motor is used to provide the static torque during the time the tape transport is stopped so that the tape path is held taut. Also, the motor is used to provide holdback torque during the rewind mode. No brake is used with this assembly.

4-38 During rewind operations, the dc motor behaves as a generator to produce a voltage which is used as the reverse motion sense signal, used in logic circuits.

4-39 COMPLIANCE ARMS AND STRAIN GAUGES

4-40 Each end of the tape path contains a compliance arm which is equipped with a strain gauge. As the forces on the tape, during motion, change, the compliance arms are deflected to adjust for the increase or decrease in the tape loops associated with the changes of forces. The deflection of the compliance arms is reflected as a change in resistance of the strain gauge which is attached to the compliance arm. This signal is used to adjust the currents in the take-up motor and brake. Current control for the reel motors and reel brake is the function of the reel servos. A full description of the reel servos is included in Section VI.

4-41 MARK XI HEAD ASSEMBLY

4-42 The Mark XI head assembly consists of a brushless dc motor, a dual function tachometer, a head drum containing four quadrature mounted heads, a control track head, vacuum tape guide, and five adjustment potentiometers for 6-tach error compensation.

4-43 The Mark XI head is shown in Figure 4-4. The complete assembly is built on a rigid base structure (i.e., base plate) which is fastened to the top plate with three hex screws. Two integral connectors on the underside of the base plate engage mating connectors located in the top plate.

4-44 BRUSHLESS DC MOTOR

4-45 The servo controlled brushless dc motor is driven with a dc voltage from the drum servo circuitry. When used in the 60-frame system the motor rotates at 240 rps; in the 50-frame system the motor rotates at 250 rps. Commutation of the dc field is accomplished by a solid state motor drive circuit. Because of the high efficiency of this type of drum motor, no auxiliary cooling facility for the head assembly is necessary. The head assembly normally operates approximately 10°F, above ambient

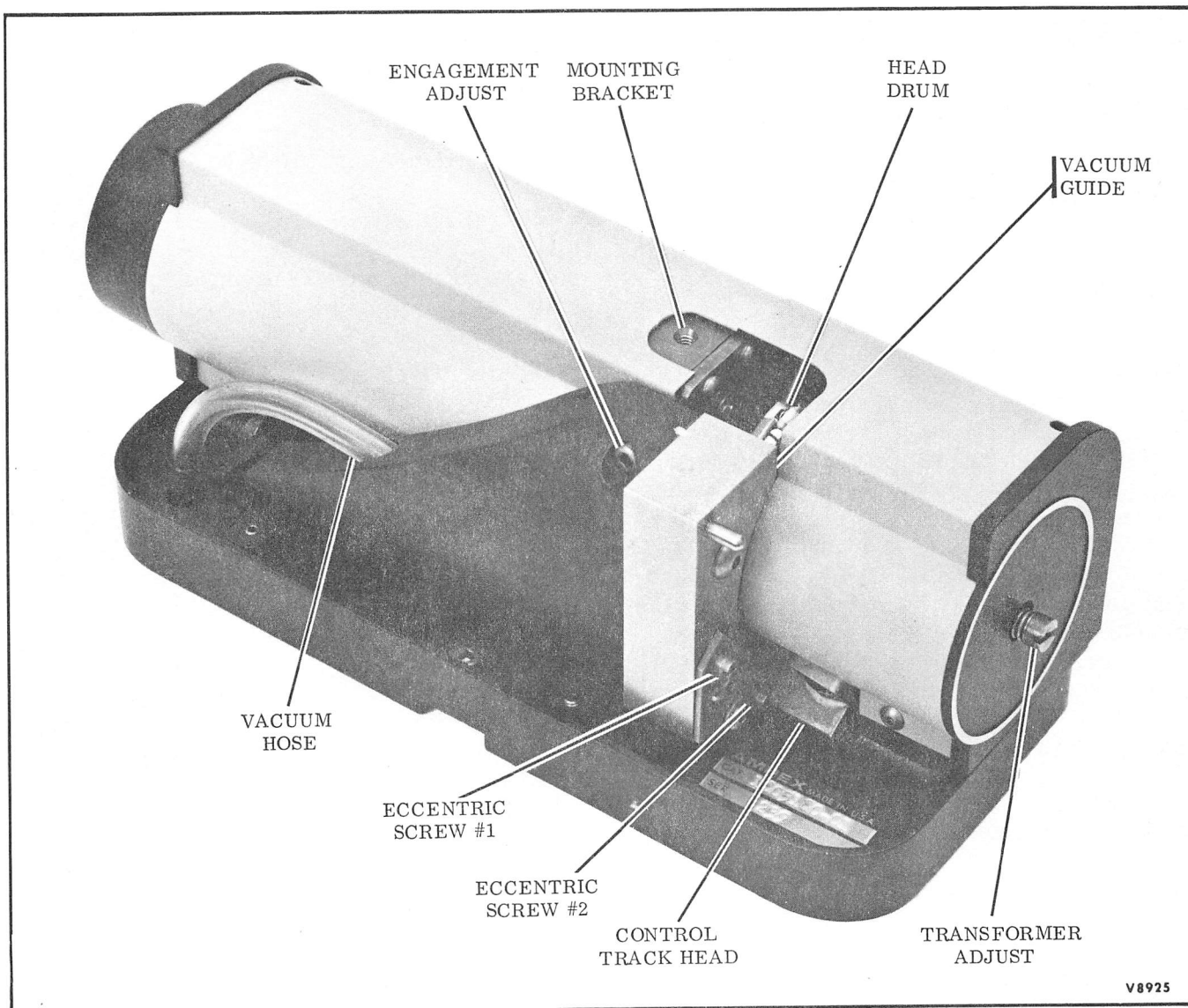


Figure 4-4. Mark XI Head Assembly

temperature. Speed control of this motor is performed by varying the dc voltage supplied to the motor drive circuit.

4-46 VIDEO HEAD DRUM

4-47 The video head drum is supported by and mounted on the armature shaft of the drum motor. The four video heads are mounted on the head drum in precise quadrature.

4-48 DUAL TACHOMETER

4-49 Two tachometer pickups are positioned over the tachometer disc, so that one "sees" six slots and the other "sees" only the one slot which is longer than the other five. When a slot passes, the reluctances of the flux path from the associated pickup abruptly changes and a voltage is generated in the pickup (transducer) coil. One of the tachometers generates six pulses

for each drum revolution while the other generates only one. The position of these pulses with respect to the position of the head drum, during its rotation, is precisely controlled during manufacture of the head assembly. These signals are fundamental to the operation of the drum servo and the capstan servo.

4-50 ROTARY TRANSFORMER

4-51 The rotary transformers are located adjacent to the video head drum. Each of the four transformers primary windings is connected to a video head. The transformer core structures are supported by the motor shaft. Thus, the primary windings rotate with the video head drum. The core structures of the associated secondary windings are supported by the base plate of the video head assembly. The output signals from the secondary windings are routed to the pre-amplifiers in the modulator/preamplifier board through J1 (head connector).

4-52 CONTROL TRACK HEAD

4-53 The control track head is mounted on the Mark XI head assembly (see Figure 4-4).

It is used to record a longitudinal track at the bottom edge of the magnetic tape (see Figure 4-2).

4-54 ADJUSTMENT POTENTIOMETERS

4-55 Five factory adjusted potentiometers are included in the Mark XI head assembly and are used to provide exact electrical compensation for the effect of finite mechanical manufacturing tolerances in the tach disc. It is recommended that these potentiometers maintain their factory settings.

4-56 AUDIO HEAD ASSEMBLY

4-57 The audio head is located in a separate head stack which is positioned to the left side of the video head assembly (facing the VTR), near the AUDIO INPUT and STD SELECT switches. This head serves as a record head and provides limited playback facilities. No audio erase head is provided in the VR-3000; during record, the audio head is used to erase a 90 mil wide track longitudinally along the length of the tape while placing the audio track in this space. (See Figure 4-1.)

SECTION V

VIDEO SIGNAL SYSTEM THEORY

5-1 GENERAL

5-2 This section contains the theory of operation for the circuitry included in the video signal paths in the VR-3000 VTR. This circuitry consists of recording facilities which are easily adapted to any of the television line standards being presently used, and limited playback facilities which are intended primarily for on-location confidence checks of the recorded video and audio.

5-3 The VR-3000 is capable of high band and low band recording in the appropriate line standard by means of a plug-in standards printed circuit board and a chassis switch. Consequently, the video signal path may be adapted to a selected line standard by plugging in the correct standards board and selecting positions A or B of the STD switch. Refer to Table 5-1 for the selection of standards boards and to Section III of this manual, under the heading of Operating Controls and Indicators for a description of the STD SELECT switch.

Table 5-1. Television Line Standards

Standards Assembly	Dash	Hi Band (A)	Lo Band (B)
1361657	01	525	525
	02	625	625
	03	819	819
	04	625	405
	05	625/819	-

5-4 VIDEO SIGNAL PATH COMPONENTS

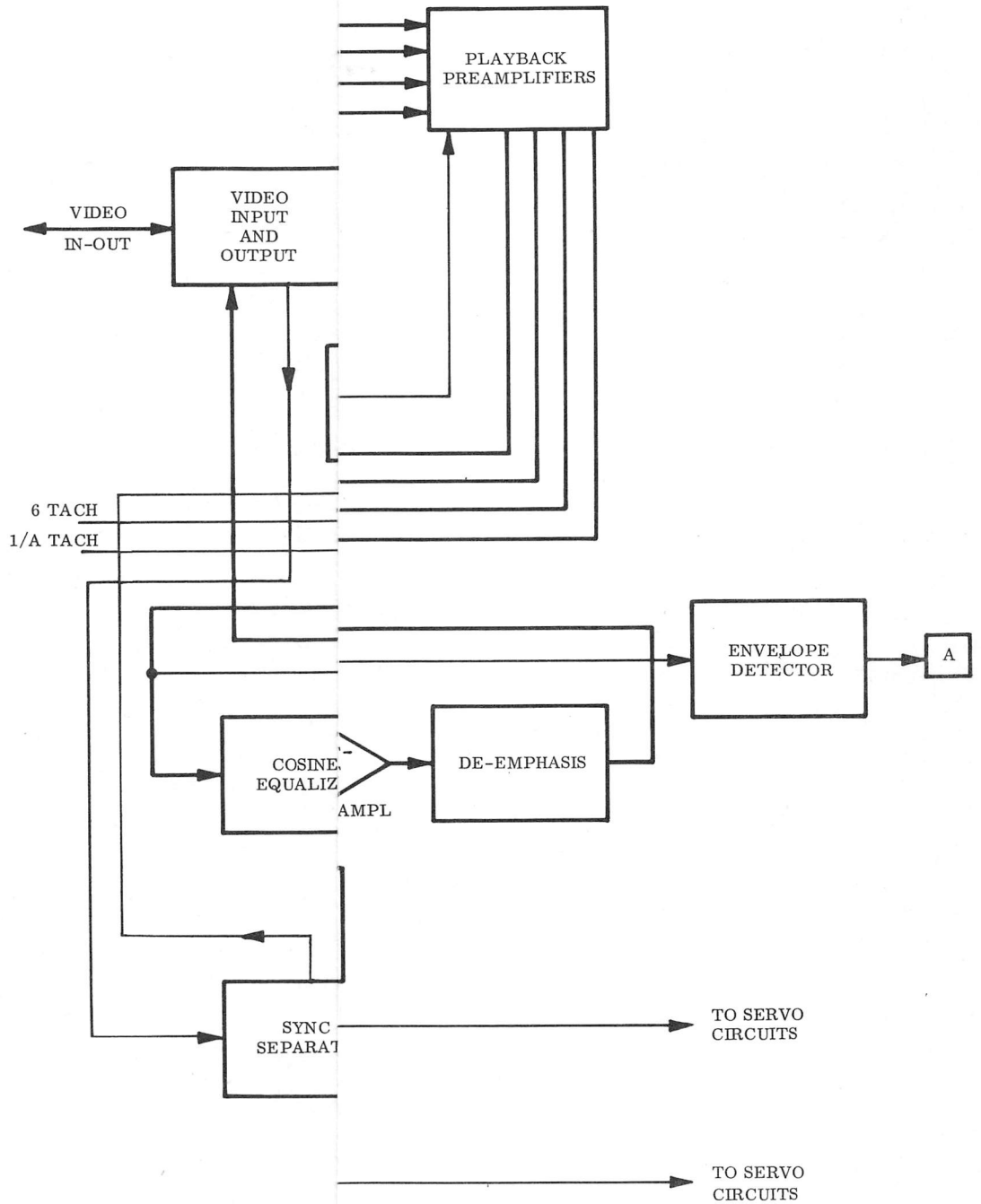
5-5 Figure 5-1 is a block diagram of the video signal electronics in the VR-3000 VTR. The record and playback electronics are contained on five printed circuit boards which are plugged into the chassis connectors. Table 5-2 lists the printed circuit assemblies which comprise the video signal electronics.

5-6 RECORD MODE ELECTRONICS

5-7 The record mode electronics include an input video amplifier, a video level detector and indicator, a pre-emphasis driver amplifier, a video clamp, a pre-emphasis network (interchangable, depending on the line standard used), a modulator, record head drivers, and rotary transformer. The record-playback switcher controls the operational mode. Figure 5-1 is a functional

Table 5-2. Signal System Printed Wiring Assemblies

Board Number	Description	Function of Contained Circuits	Part Number
18	INPUT & OUTPUT VIDEO	Video Amplifier Input/output switching	1361582
19	STANDARDS	Low pass filter, Sync separator, Pre-emphasis network, De-emphasis network, Vertical sync separator, Vertical one-shot, Odd field detection, Frame pulse trigger generator	1361657
21	MODULATOR PREAMP	Modulator Record Head drivers Playback preamplifier Record playback head switching	1361576
22	SWITCHER EQUALIZER	Playback switcher logic Switchers/channel amplifiers Cosine equalizer R. F. Low pass filter	1361578
23	DEMOD FILTER AMP	Limitors Demodulator Filters (L. P. and Phase equalizer) Clamp and transient suppression Output amplifier	1361580



V8842

Figure 5-1. Signal System Overall Block Diagram

Table 5-3. Level to Carrier Frequency Correlation

STD Position	Line Standard	Sync Tip Carrier Freq.	White Level Carrier Freq.	Blanking Level Carrier Freq.
A	525 HB	7.06 MHz	10.00 MHz	7.90 MHz
B	525 LB	4.28 MHz	6.80 MHz	5.00 MHz
A	625 HB	7.16 MHz	9.30 MHz	7.80 MHz
B	625 LB	5.00 MHz	6.80 MHz	5.54 MHz
A	405	4.28 MHz	6.80 MHz	5.00 MHz
*	525 Color	5.50 MHz	6.50 MHz	5.786 MHz

* 525 color, line standard, is not available except upon special request.

block diagram of the signal system, and includes the record electronics.

5-8 A composite video signal (approximately 1 volt peak-to-peak, negative going sync) is coupled to the input amplifier at J18-C, through chassis mounted coaxial connector J7. When a camera is used, the video input from the camera is through J1-L. The signal is then routed to a pre-emphasis driver having its output connected to a pre-emphasis network and a video level detector. The modulator is a voltage-controlled fm generator; the output frequency of the modulator is proportional to the instantaneous dc level at its input.

5-9 Table 5-3 shows the proper white level, blanking (black) level, and sync tip level modulator frequencies for each position of the video standards selector switch.

5-10 The output of the modulator is an rf signal which is coupled to the inputs of the record head driver circuitry. The record head drivers raise the power of the rf signal to a level suitable to couple through the rotary transformers and drive the video heads.

5-11 PLAYBACK ELECTRONICS

5-12 The playback electronics include playback preamplifiers, switcher/channel amplifiers, playback switcher logic, a cosine equalizer, an R.F. filter, limiters, demodulator, a video low pass filter, a video phase equalizer, a de-emphasis network, and output video amplifier. Figure 5-1 is a block diagram of the signal system electronics.

5-13 When the playback mode is selected by the record playback switching, the playback preamplifiers are connected to the rotary transformers through forward-biased diodes. The four signals are amplified in the playback preamplifiers. Inputs to the switcher/channel amplifiers consist of the four signals from the playback preamplifiers and playback switcher logic signals from the playback switcher logic. The quadrature signals are reassembled into a continuous signal. Output from the switcher/channel amplifier is connected to the cosine equalizer and the envelope detector. The envelope detector is used to provide a test point signal. The cosine equalizer, because of its shaped response characteristics,

reestablishes the required amplitude relationships between the rf carrier and the sidebands. The R.F. low pass filter limits the signal to that which is required for playback. The rf signal is then amplitude limited and demodulated.

5-14 The playback switcher logic circuits accept head drum position information in the form of tachometer signals (6-tach and 1/A tach) and video switching information (vertical clamp pulse), and converts this to a switching square wave. The demodulator accepts rf from the limiters to produce the video spectrum and spurious harmonic components. The low pass filter limits the upper frequencies of the demodulated video signal and removes the spurious components from the video. The phase equalizer readjusts the relative phase of the spectrum of video frequencies. The output amplifier amplifies the video signal and provides clamping of the horizontal sync tips to ground. During playback, the video input output circuits are used to amplify the outgoing signals.

5-15 STANDARDS ELECTRONICS

5-16 The standards circuits are used as the pre-emphasis networks for recording, de-emphasis networks for playback, sync processing circuitry, and carrier frequency control circuitry for the modulator. The above functions share a common requirement: each must be tailored to suit the line standard being recorded in the VTR.

5-17 The pre-emphasis, de-emphasis, and rf carrier frequency defining circuitry is discussed in this section under the appropriate heading where the record or playback circuits require the use of the standards circuit. The sync processing circuitry is discussed separately.

5-18 The sync circuits consist of the sync separator, vertical sync separator, odd field detection, vertical one-shot, frame pulse generator, and vertical pulse generator. The sync is separated from the composite video signal. The vertical sync

separator detects the long vertical sync pulse from the shorter horizontal pulses. To determine the point in the video signal where a complete frame is finished, the odd field detection circuit and the vertical one-shot signals are used as input for the frame pulse generator circuit which generates the frame pulse. The odd field detection circuit senses the timing relationship between the last horizontal pulse and the first equalizing pulse, which are different in alternating fields.

5-19 INPUT VIDEO (Board #18)

5-20 The composite video signal is connected to input terminal J18-C. This is shown in Figures 5-2 and 10-8. Relays K1 and K2 switch the input video to the amplifier consisting of Q1, Q2, Q3, Q4, and Q5. Relay K1 operates in playback mode, only when a camera having a CRT viewfinder (such as the BC300) is used as the source of video. Relay K2 operates in the playback mode to switch the source of video for the video amplifier from the video input at J18-C to the playback video. Relay K1 also operates in the playback mode to switch the output (playback video) of the video amplifier back to the camera viewfinder which is now serving as a playback monitor.

5-21 Resistor R18 and inductor L1 which are connected to the junction of the normally closed (nc) contacts of K1 and K2, are the coaxial cable termination during record. Transistor Q1 is an emitter follower which lowers the impedance to the emitter of Q2. The amplified video signal is taken from the collector of Q2 and is connected through zener diode VR2 to the base of emitter follower Q3. Transistor Q4 also serves as an emitter follower. A feedback path both for signal and dc balance is provided from the emitter of Q4 to the base of Q2, through the voltage divider R1, R2, R3. Potentiometer R1 is used to adjust the gain of the video amplifier. Transistors Q4 and Q5 comprise a totem-pole circuit, having very low impedance output at the junction Q4 emitter and Q5 collector. Average gain of this circuit from the input at J18-C to the output at J18-3 is approximately 10 dB,

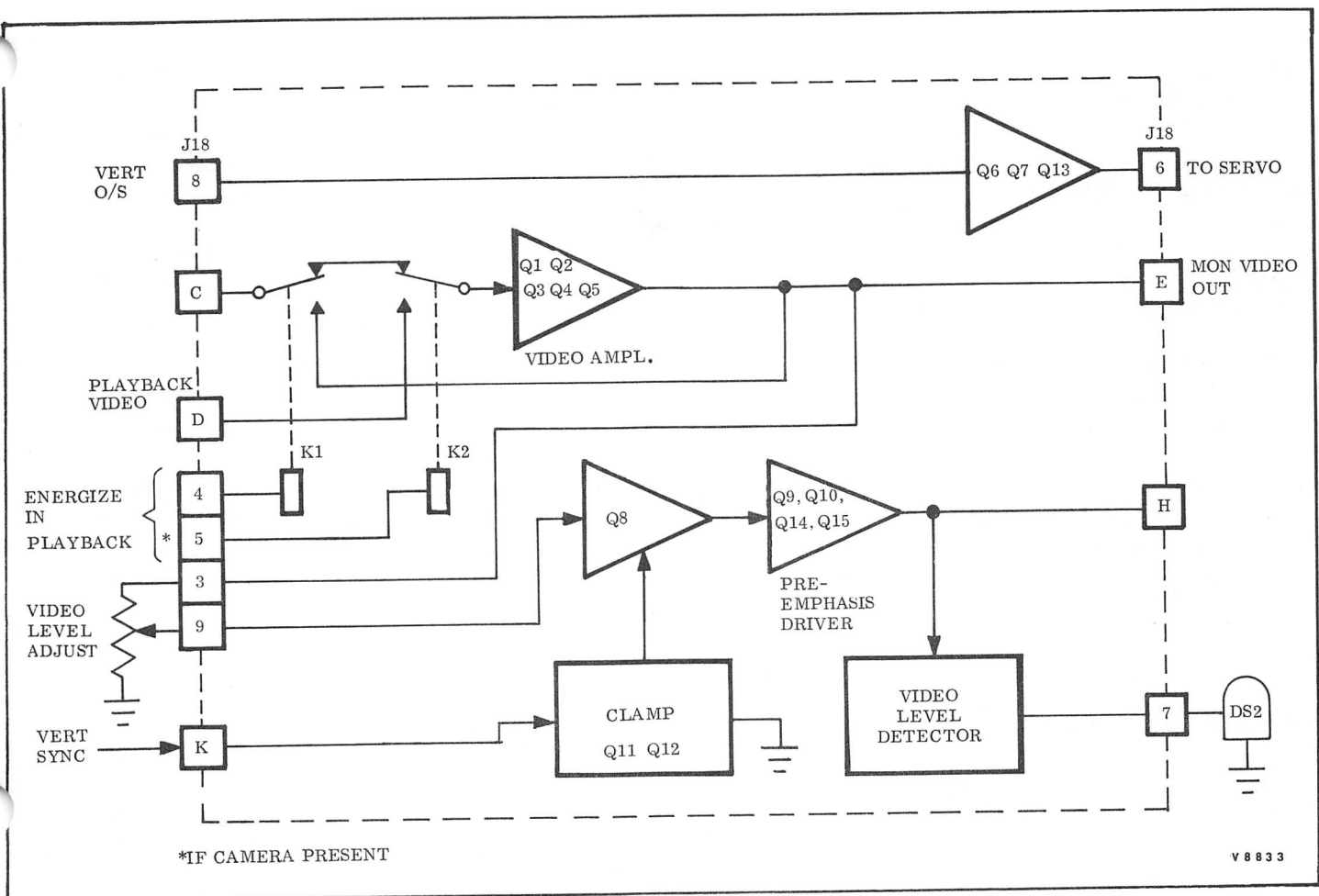


Figure 5-2. Input and Output Video Block Diagram

and unity gain to the terminated monitor video output.

5-22 Figure 5-3 is a simplified schematic diagram of a totem-pole amplifier. With no input signal, transistors Q4 and Q5 are biased into conduction and pass equal amounts of current and there is no resultant output signal. Resistors R5 and R6 form a voltage divider, as do R12 and R13. A positive-going input signal causes Q4 to conduct more heavily and pass more current from the +12 volt source, through R6, to the output load. As more current is drawn through R6, the voltage across it increases. The resulting less-positive voltage at the junction of R5 and R6 is coupled through VR1 and C2 to the base of Q5, reducing the current through Q5.

5-23 Conversely, a negative-going input signal at the base of Q4 causes it to turn off, decreasing its current. The current in Q5 correspondingly increases because of the connection through VR1 and C2 from Q4-collector to Q5 base. The current in Q4 is thus held constant by dividing it between the load and Q5 for all input voltages at the base of Q4. The gain is controlled by the feedback network R3, R2, and R1.

5-24 Potentiometer R6, as shown in Figures 5-2 and 10-8, is mounted on the chassis and is a screwdriver-adjusted deviation control. It is included as an external adjustment to allow for the recording of non-standard amplitude signals, or highly attenuated signals from remote cameras whose location warrants the use of long runs of

coaxial cable from the camera to the VTR. This adjustment is described in Section IX, under maintenance. The input video signal must contain a clipped white level as produced from a 100%, white clipper in a camera. When the camera has sufficient light to produce a clipped, white level, potentiometer R6 is adjusted so that the VIDEO LEVEL indicator on the chassis just lights.

5-25 PRE-EMPHASIS DRIVER AND VIDEO CLAMP (See Figures 5-2 and 10-8)

5-26 The video signal from potentiometer R6 is connected through J18-9 to the base of emitter follower Q8. Transistors Q11 and Q12 comprise a clamp (dc restorer) circuit. The back porch of each horizontal blanking period is held at approximately ground potential by having the clamp operate during the back porch time of the blanking period.

5-27 Emitter followers Q9, Q14, together with Q10, Q15, form the pre-emphasis driver. This circuit provides a high impedance input for the signal from the clamp circuit, while the output signal, to drive the pre-emphasis network on the standards board, has an impedance of approximately 75 ohms. Video output is provided at J18-H.

5-28 VIDEO LEVEL DETECTOR

5-29 The video level detector as shown in Figures 5-2 and 10-8 consists of the differential comparator A1 and transistors Q16 and Q17. Input is taken from the pre-emphasis driver and connected through a low-pass filter consisting of L2, C11, C12. This signal is then connected as the non-inverting input to the comparator at A1-2. A reference signal from voltage divider R41, R42 is used as the input signal for the inverting input at A1-3. The output of the comparator at A1-7 is negative for all signal inputs at A1-2 which are more negative than the reference voltage at A1-3, and positive for all signal inputs which are more positive than the reference voltage.

5-30 For all signals which are smaller in amplitude than the reference voltage, transistors Q6 and Q17 are held in cut-off. These transistors comprise a trigger circuit, switching on as the input voltage exceeds a fixed level and switching off when the input voltage is less than the fixed voltage level. Switching feedback (regenerative feedback) is provided through capacitor C10. When Q17 conducts, the lamp current flows from the +12 volt supply through Q17, R39 and the VIDEO LEVEL INDICATOR lamp DS2, to the -12 volt supply. When transistor Q17 is in cut-off, lamp current flows from ground, through diode CR8, resistor R39 to the lamp DS2. This small, idle current is provided to speed up the lamp response time for short signal transients.

5-31 PRE-EMPHASIS

5-32 The recording pre-emphasis network is included as part of the standards board. Because of the different requirements for the various standards, the circuitry performing the pre-emphasis operation is different on the five configurations of standards boards. Table 5-4 lists the component values for the various configurations of pre-emphasis network; Figure 5-4 shows a partial schematic.

5-33 MODULATOR/PREAMPLIFIER (Board #21)

5-34 FREQUENCY CONTROL

5-35 The pre-emphasized video signal is brought in to the modulator board through pin J21-V, to the emitter of Q41 as shown in Figures 5-5 and 10-9. A dc voltage is brought in from the standards board, through pin J21-U, and is summed with the video signal at Q41-emitter. This dc voltage defines the carrier frequency of the fm signal by shifting the dc level of the video at the collector of Q41. Refer to Table 5-3 for the proper carrier frequency for any given video standard.

5-36 MULTIVIBRATOR (See Figure 10-9)

5-37 The output of Q41 is fed through cascaded emitter follower Q40 and Q39 to a

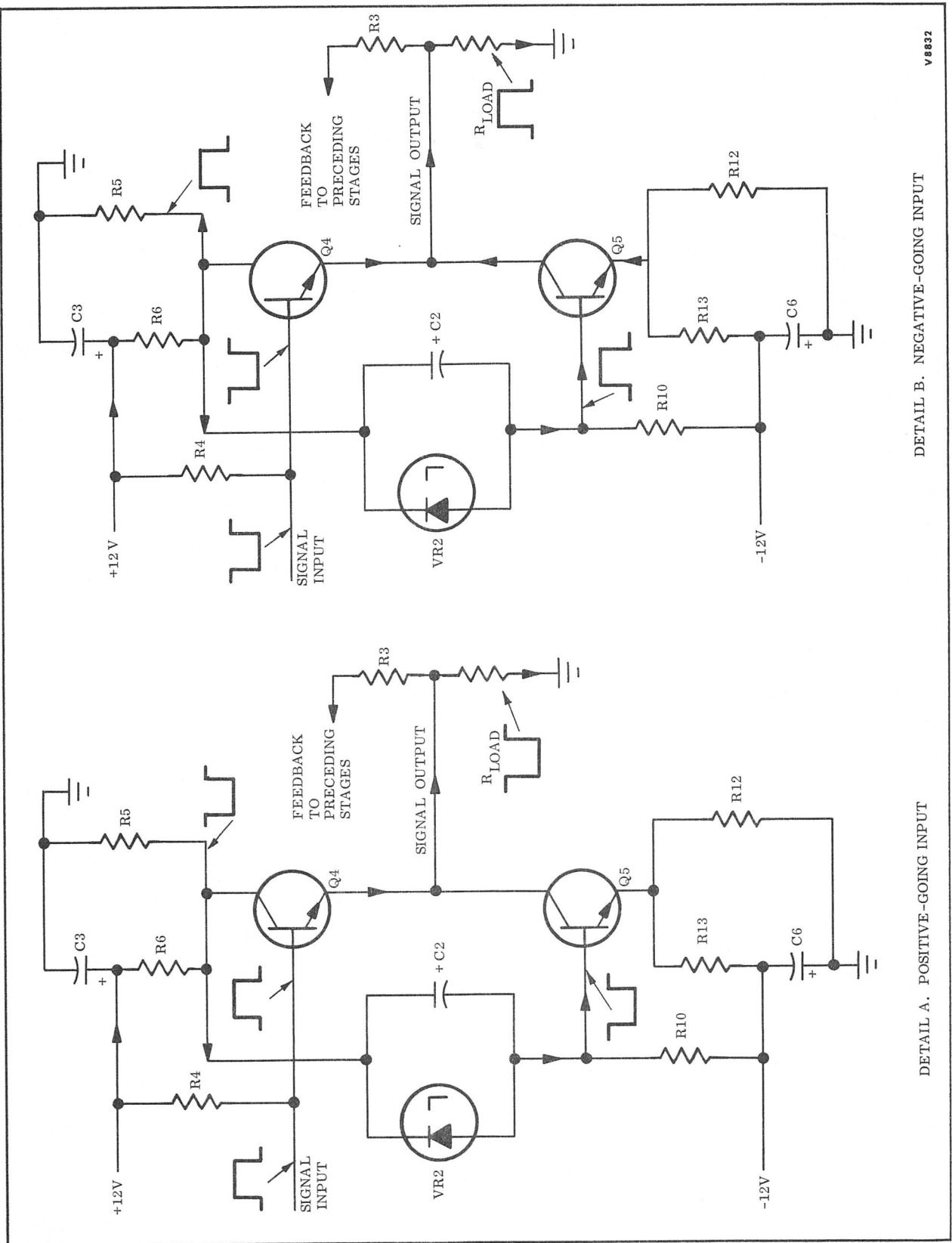


Figure 5-3. Totem-Pole Amplifier, Simplified Schematic

Table 5-4. Pre-Emphasis Networks

Line Standard	R4 ohms	R5 ohms	R6 ohms	R7 ohms	C2 pf	C3 pf
525 HB	-	-	121.9	407.8	-	1471
525 LB	634	8.72	-	-	207.9	-
625 HB	-	-	223.4	560	-	1071
625 LB	732	221	-	-	214.7	-
405 LB	634	8.72	-	-	207.9	-

voltage-controlled multivibrator consisting of Q27, Q29, Q30 and Q34. Transistors Q27 and Q34 form the basic multivibrator: Q29 and Q30 reduce capacitance at the collectors of Q27 and Q34 and supply a low-impedance path for capacitors C42 and C43. Transistors Q28 and Q33 provide a constant current charging source for C42 and C43.

5-38 The charging current for C42 and C43 is modulated by varying the current supplied to the emitters of Q28 and Q33, which are in a grounded base configuration, thus providing a highly linear control of frequency. The symmetry of the multivibrator is set at the factory by adjusting the balance control R115 for equal charging rate of the two capacitors: second harmonic content is at a minimum in the output signal.

5-39 Transistors Q31 and Q32 serve as emitter-follower outputs for the rf signal, connected to the RF DUB OUT terminal at pin J21-R. Transistors Q20 and Q21 are emitter followers used to drive the primary winding of transformer T1.

5-40 Potentiometer R117 is a factory adjusted control which determines the sensitivity of the modulator. It is set so that a 100%, white signal measured at the MON VIDEO OUT test point (1 volt peak-to-peak), causing the VIDEO LEVEL INDICATOR DS2 to just light, produces the correct rf carrier deviation for the line standard in use. The VIDEO LEVEL ADJ control, which is accessible from the chassis, is adjusted so

that a non-standard amplitude video signal produces correct carrier deviation out of the modulator.

5-41 Potentiometer R90 adjusts the total current into the multivibrator charging capacitors C42 and C43 and, consequently, it controls the carrier frequency. Potentiometer R91, SYM, adjusts the ratio of frequency adjusting (static) current to each half of the multivibrator. Potentiometer R104, BALANCE, adjusts the ratio of video currents to the two multivibrator charging capacitors. The adjustments are described in Section IX under the heading of maintenance.

5-42 When the multivibrator is in operation, one of the transistors (Q27 or Q34) is turned on and one turned off. If Q27 is turned on, Q34 is thus turned off; the collector of Q34 rapidly approaches the +12 volt level, but is limited at +4 volts by CR5. The current through R109 charges capacitor C47. If Q34 is turned on and Q27 is turned off, the process of charging C47 is repeated through R94.

5-43 STARTING OSCILLATOR

5-44 As the multivibrator is extremely well balanced there is a chance that Q27 and Q34 might both turn on when power is first applied to the modulator, and no oscillations will occur. If this happens, however, no current will flow through the limiting diodes to the +4 volt regulator Q35. When the multivibrator is oscillating

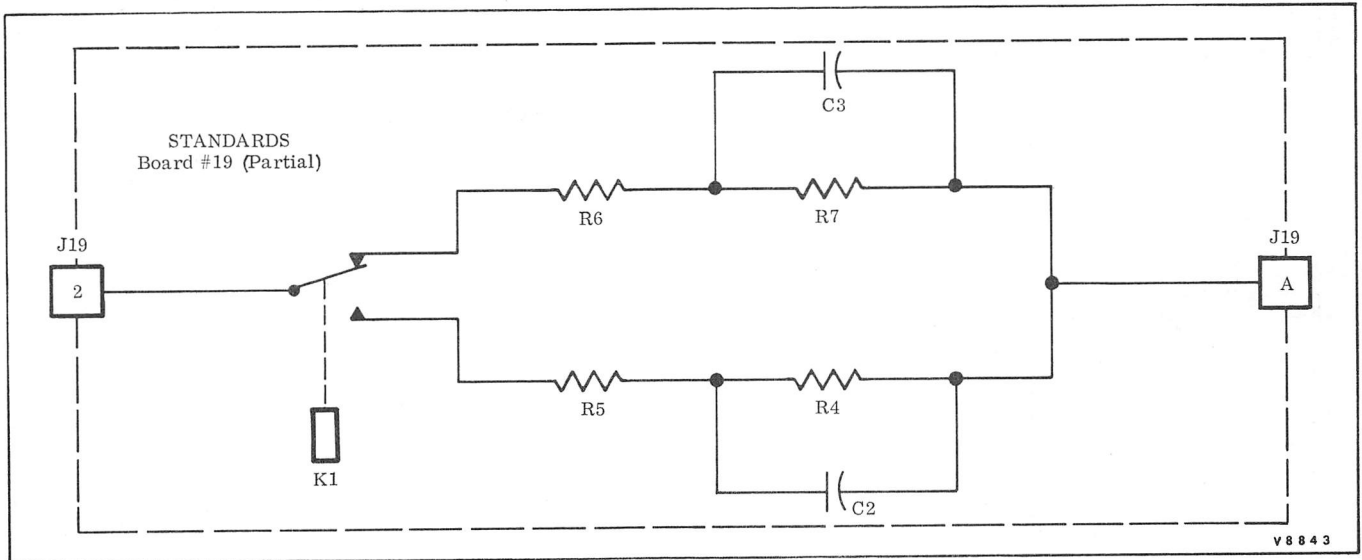


Figure 5-4. Pre-Emphasis Network

properly, current flows alternately through CR5 and CR6. If the oscillator fails to start, the voltage at the collector of Q35 becomes more negative and Q37 starts to conduct. Transistor Q37, in turn, turns on the unijunction transistor oscillator Q38; the signal from Q38 is amplified in Q36 and is used to turn on CR7 to unbalance the multivibrator long enough to start oscillation. When current is again drawing from Q35, the starting oscillator turns off.

5-45 RECORD HEAD DRIVERS

5-46 The record head drivers shown in Figures 5-5 and 10-9 accept the rf signal from the secondary of transformer T1 (simultaneous application of the rf signal to all four record head drivers), amplify it, and feed the rf to each of the four video heads, through the rotary transformers. The four record head drivers are identical in operation. A record head driver consists of a dual-device, differential amplifier and a voltage regulator transistor. It includes circuitry for controlling the recording level of each head.

5-47 The record head drivers consist of differential amplifiers Q11, Q12, Q13 and Q14. Transistors Q5, Q4, Q16 and Q17

serve as constant voltage sources, with adjustable outputs. For description purposes, only one of the four video record head drivers is discussed. Video input from the modulator is coupled through transformer T1 to both base elements of Q11. The secondary, center tap of T1 is connected to the emitter. As the rf signal from T1 oscillates, the two halves of Q11 alternately switch from a condition of saturation to a cut-off state. The collectors are connected, each to a half of the winding on the rotary transformer. Current supply to the winding and the collectors of Q11 is through the center tap of the rotary transformer.

5-48 Transistor Q5 is a low impedance voltage source which is adjustable with head drive potentiometer R1. This potentiometer sets a dc level at the base of Q5 because of emitter follower action, at the center tap of the rotary transformer winding. The current path alternates between the two halves of the winding, depending on which half of Q11 is saturated and which half is in cut-off. Because of the saturated condition of the conducting half of Q11, The transformer current (also head current) depends on the voltage difference. Thus, the head current is adjusted by potentiometer R1.

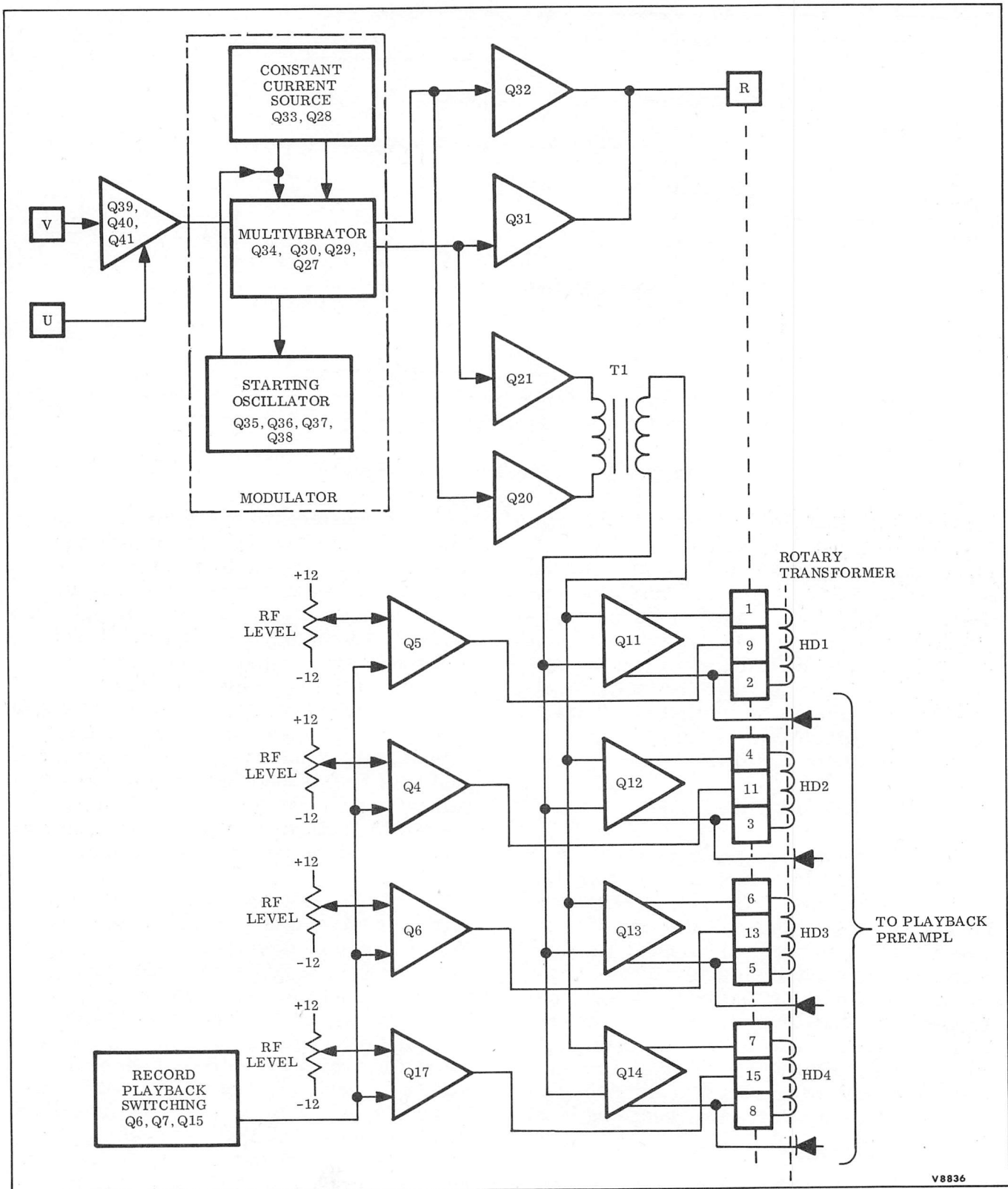


Figure 5-5. Modulator Preamplifier Block Diagram

5-49 RECORD PLAYBACK SWITCHING

5-50 The record playback switching electronics functions in both the record modes and playback modes. The head functions in both modes and requires switching from the record circuit to playback preamplifier circuits. Figure 5-6 shows a simplified schematic of the record playback switching circuits.

5-51 During record mode, the -12V REC voltage and the -12V SIG voltage are both present. Because of the presence of the switched rf voltage at the secondary of T1, each of the differential amplifiers is functioning as described in the above paragraph (record head drivers). Current flows alternately in each half of the rotary transformer winding. Diode CR1 is cut off. This is due to the presence of the -12V REC input. Transistor Q15 is in cut-off, allowing the -12 volts to be present at L3. Thus, the anode side of CR1 is at -12 volts. Because Q6 and Q7 are in cut-off, the source of current must be from the constant voltage source, Q5. This voltage is always less than -12 volts (more positive) and diode CR1 is back-biased, restricting current and signal flow. The recording current is developed from the low impedance voltage at Q5-emitter, flowing alternately in each half of the rotary transformer winding.

5-52 During playback, the presence of the -12V PLAYBACK voltage biases Q7 and Q15 into conduction. Transistor Q15 conducts and places the end of inductor L3 at ground potential. When Q7 conducts, Q6 also conducts and the -12V SIG voltage is present at the collector of Q6. Current flows through R6, R22, the 9-2 half of the rotary transformer, CR1, L3, to ground through Q15. The direction of current flow in this case is opposite to the order described above; current flows from ground toward the -12V SIG line.

5-53 When CR1 is forward biased, it provides continuity for the rf signal from the head. Capacitor C13 provides rf bypassing to ground for the signal and serves as the

signal return point. The signal is connected through CR1 to the input of the playback preamplifier. Inductor L3 serves as a signal decoupling device and operates to separate the signal path from the record playback switching path.

5-54 PREAMPLIFIERS

5-55 In addition to providing an fm carrier during record, the modulator preamplifier board contains four preamplifiers which are used to match the output impedance of the heads and to amplify the respective head signals. These four preamplifiers are identical in operation. The circuitry associated with head #1 is described below.

5-56 The preamplifier shown in Figure 10-9 consists of a cascode amplifier Q1 and Q2, having its output feeding the base of emitter follower Q3. Feedback is provided from Q3-emitter to Q1-base, through C5 and R14. Together with inductor L1, these components comprise a degenerative feedback network to lower the input impedance of the preamplifier.

5-57 SWITCHER EQUALIZER (Board #22)

5-58 The switcher equalizer board consists of the switcher channel amplifiers, playback switcher logic, cosine equalizer, rf low-pass filter, envelope detector, and clamp amplifier. These circuits are shown in Figures 5-1, 5-7, and 10-10.

5-59 The switching circuit combines the signals from the four video head channels to form a continuous train of reproduced information. As head #2 is leaving the tape, head #3 is starting its travel. At that point, the signal system ceases to receive rf signals from head #2 and starts to receive rf signals from head #3. During the short period when both heads are playing back the same information, it is possible to switch from one head to the next. This switching takes place during the back-porch time. Clamping the composite video to the blanking level during the switching time eliminates both the additive transients and head

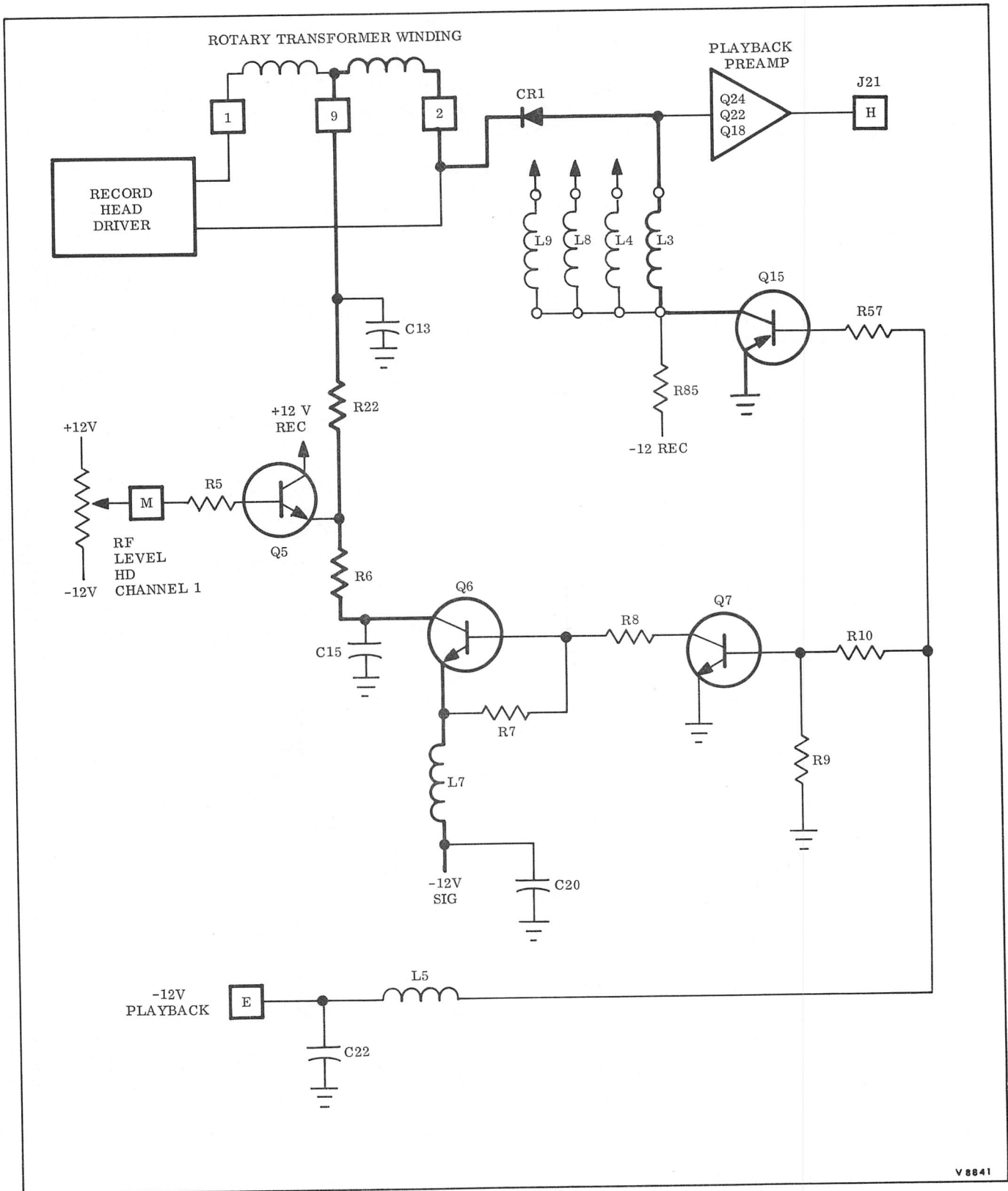
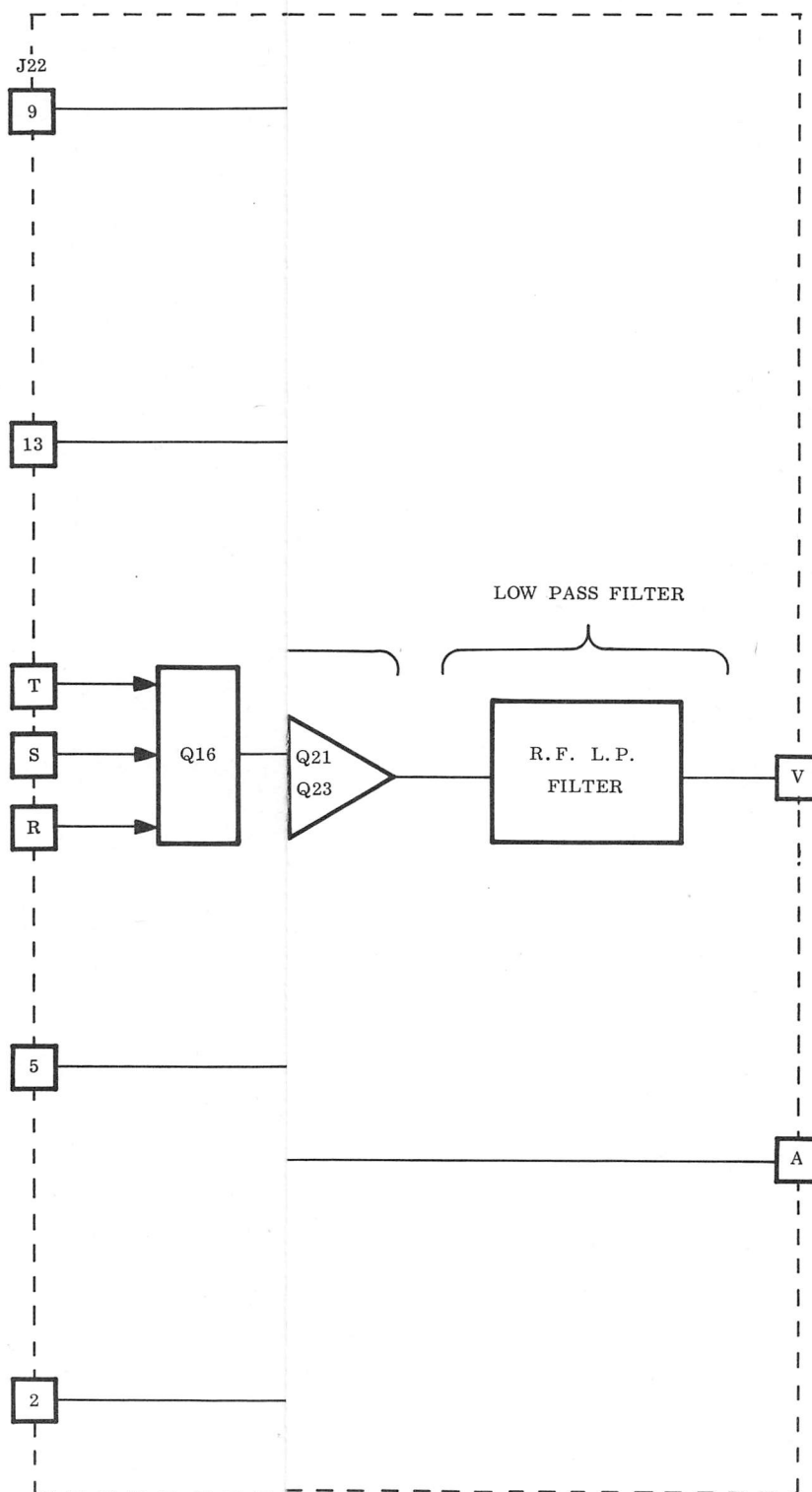
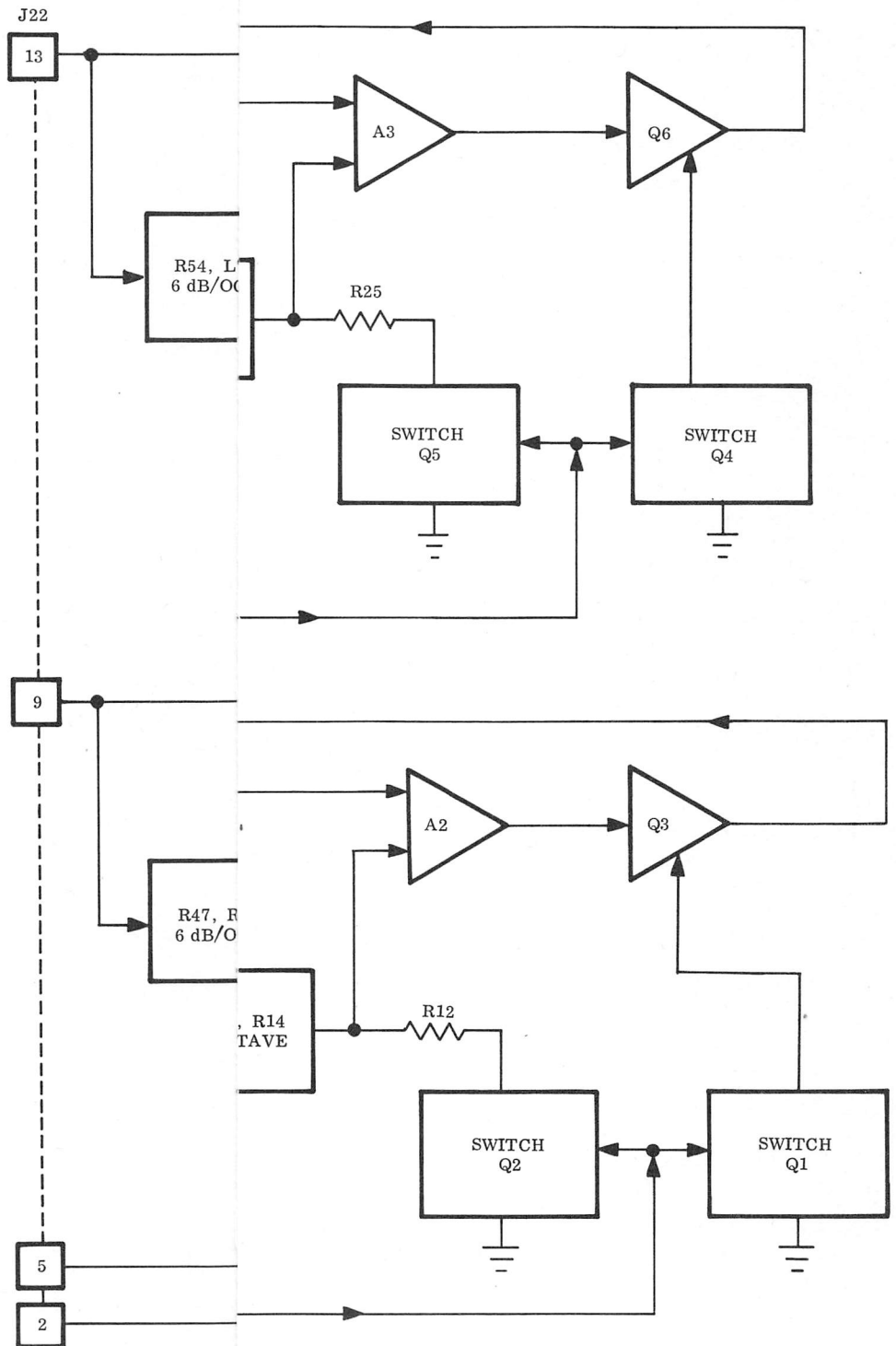


Figure 5-6. Record/Playback Switching Simplified Schematic



V8837

Figure 5-7. Switcher Equalizer Block Diagram



V 8840

Figure 5-8. Switcher Channel Amplifier

switching transients (caused by phase discontinuities in the fm carrier when switching from one head to the next). This clamping action for transient suppression takes place in the output amplifier of the demodulator filter amplifier board #23.

5-60 SWITCHERS CHANNEL AMPLIFIERS

5-61 The switchers channel amplifiers are shown in Figure 5-8, block diagram, and Figure 10-10, schematic. Each channel contains identical circuitry which performs the same function for the respective channel. The playback switcher logic circuits generate the signals which control head switching sequence.

5-62 The signal from head #1 is routed through playback preamplifier to J21-A and J22-13. The head compensation network L7, R53, R54 and R55 provides an upward slope of six decibels per octave to compensate for the response of an inductive head working into the low input impedance of the head preamplifier.

5-63 Terminal A5-1 is the non-inverting input to RF amplifier A5. The head compensation network is connected in series with the signal to the inverting input at A5-3. The rising impedance, as frequency is increased, produces a six decibels per octave, rising response at the output A5-5.

5-64 The output of the RF amplifier at A5-5 is coupled through C14 to the base of Q14. Transistor Q14 is connected in common emitter configuration and shares a common collector load with the circuitry associated with transistors Q3, Q6 and Q10. This load consists of L5, L6, and R60. Transistors Q11 and Q12 serve as the switch for the signal from head #1. When the signal from head #1 is to be switched on, a positive voltage is applied at the junction of R43 and R48. Conversely, to turn off the head #1 signal, a ground potential is applied at the same junction.

5-65 The switcher logic circuitry supplies the necessary control signals for the four

switchers/channel amplifiers. A positive voltage causes both Q11 and Q12 to conduct and provide a low impedance path to ground for the emitter of Q14 and for the terminating resistor R53. Grounding the emitter resistor of Q14 provides a path for base current and collector current. Without the normal collector currents, C14 ceases to function as a positive gain device and actually attenuates any signal at its base element.

5-66 Without termination, the head compensation network L7, R53, R54, R55 sees the high impedance (over several megohms) of the input terminal A5-3. For the frequency range involved, the network appears as a relatively low impedance series element in the signal flow and has no appreciable effect. Thus, the non inverting input at A5-1 and the inverting input at A5-3 have identical signals which effectively cancel each other. When transistor Q12 conducts, R53 is shunted to ground. The input at A5-3 now appears as a 51-ohm termination. The inclusion of R53, L7 and R54 in series with this inverting, 51-ohm input terminal provides a signal which decreases with the increase in frequency. The overall output spectrum at A5-5 is a rising response curve at a rate of six decibels per octave.

5-67 SWITCHER LOGIC

5-68 The switcher logic block diagram is shown in Figure 5-9; the timing waveforms are shown in Figure 5-10. This circuitry is used to generate four timing signals which are used as gating signals for the four switcher/channel amplifiers. The four output signals from the switching logic circuits are synchronized with the phase of head drum rotation and horizontal line synchronization pulses (in this case the clamp pulse generated in the sync separator of the standards board, delayed to coincide with the back porch). Each of the four switching logic signals becomes positive for 90 degrees of drum rotation, the time for one head to make its pass over the tape. To avoid switching during actual video information, the switching is made to occur during the back porch time.

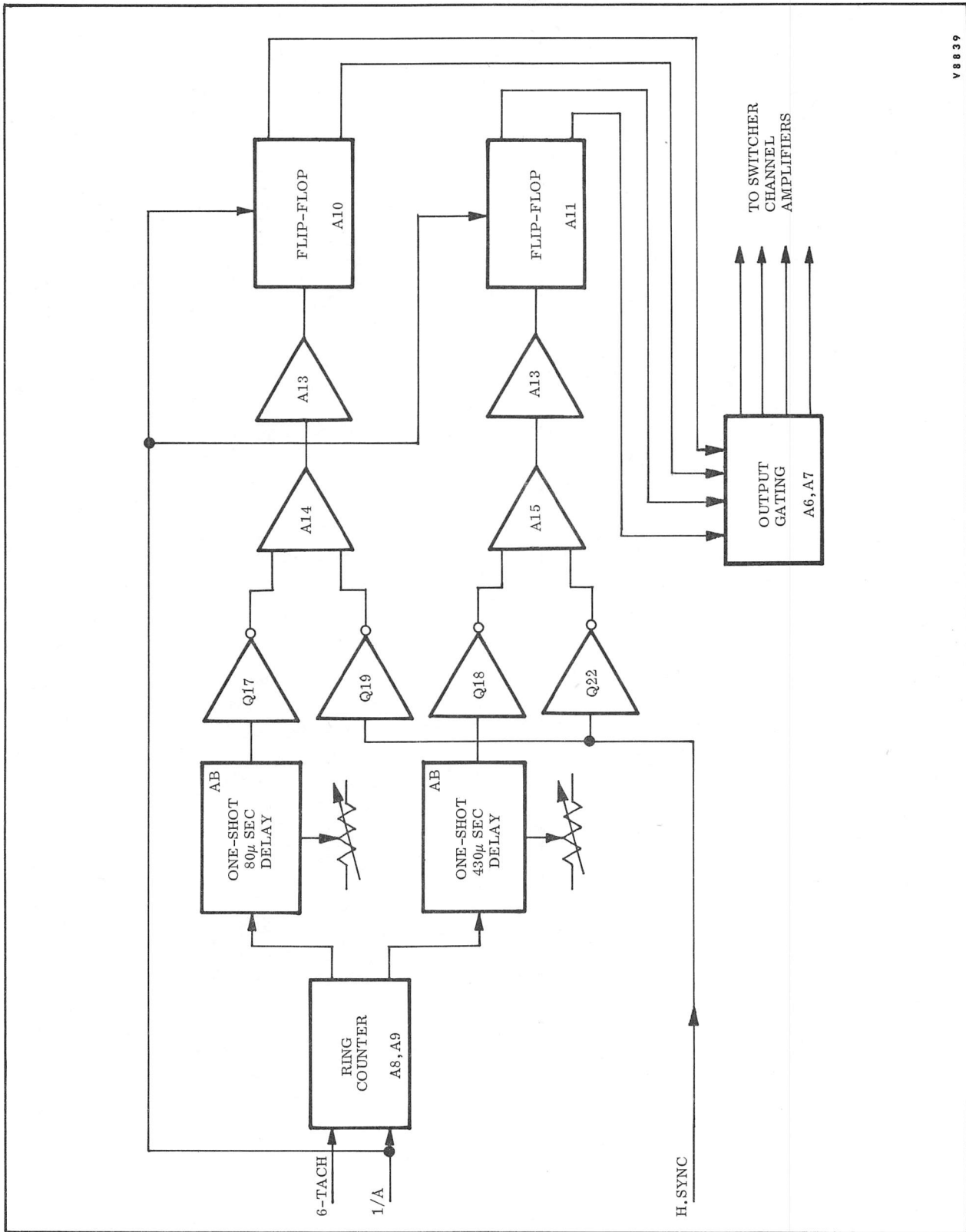
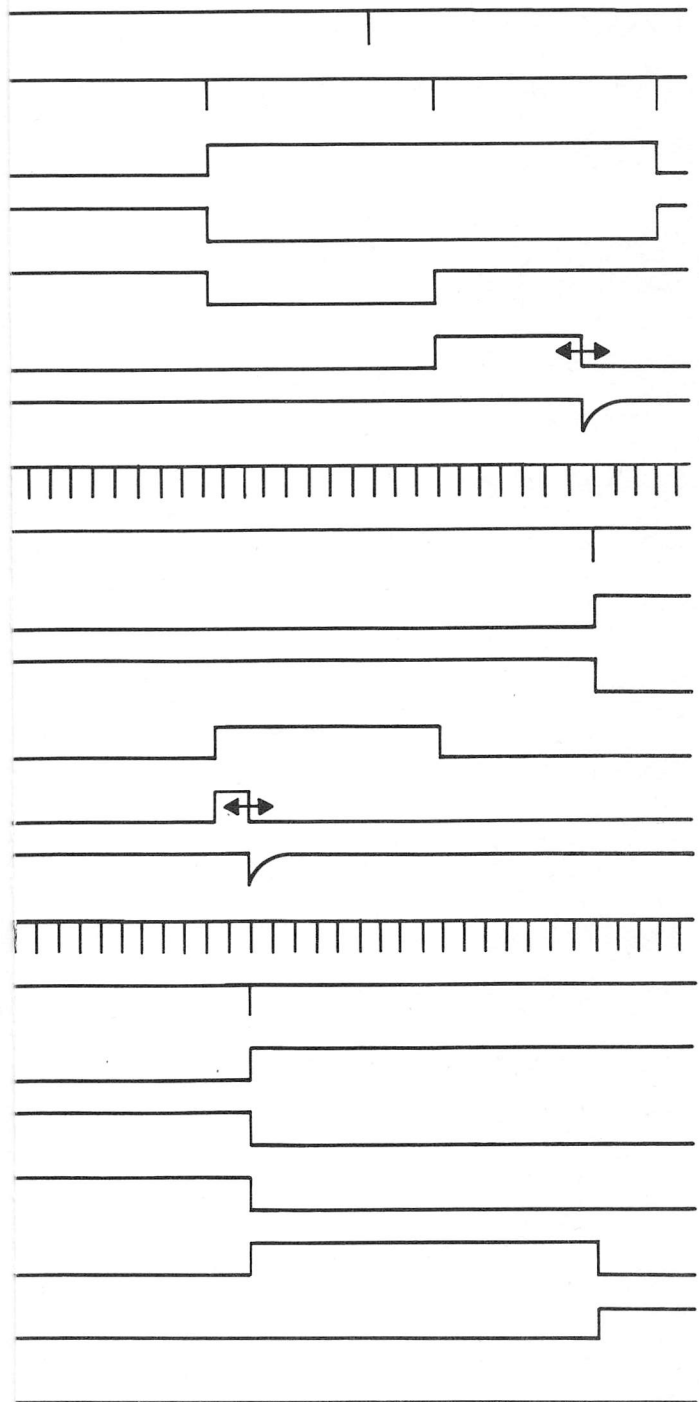


Figure 5-9. Switcher Logic Block Diagram

MPEX



V8844

Figure 5-10.
Switching Logic Timing Waveforms

5-69 Flip-flops A8 and A9 comprise a ring counter which divides the 6-tach pulse periods by a factor of three. The output signal at A8-5 is complementary to the signal at A8-7.

5-70 Two switching delay channels are used, with corresponding input signals from A8-7 and A8-5 respectively as shown in Figure 10-10. Each of these switching delay channels introduces a delay of 80 microseconds and 430 microseconds to the rising edges of the output pulses at A8-5 and A8-7 respectively. This produces two alternating pulse trains which together divide the drum rotation period into 90-degree intervals.

5-71 These alternating pulse trains are used to trigger the differentiating circuits of C77, R29 for the switching delay #1, and C30, R82 for the switching delay #2. Both of these timing circuits introduce a 100 microsecond, negative-going transient pulse at the non-inverting inputs of A14-2 and A15-2 respectively.

5-72 In switching delay channel #1, inverter A13 and transistor Q17 comprise the one-shot switching delay with R78, R65 and C24 serving as the timing components. The output at Q17-collector is a positive pulse starting at the instant coincident with the rising edge of the pulse at A8-5 and lasting for approximately 80 microseconds, at which time the trailing edge of the pulse occurs. This trailing edge is differentiated by C29 and R77 to produce a negative voltage excursion at A14-2. This signal at A14-3 is normally at ground potential due to the conduction of Q19.

5-73 The negative-going pulse at A14-2 is less positive than the ground potential at A14-3, therefore the output at A14-7 switches toward ground. This allows the voltage at the base of Q19 to be zero and Q19 goes to cut-off. The voltage at A14-3 now assumes the level which is defined by the voltage divider R75, R76. It should be noted that even with the change in voltage at A14-3, the voltage at A14-2 is still less positive and the output at A14-7 remains at 0 volts. The

voltage across C29 begins to increase because of the charging current from the +3.6 supply, through R77. When the voltage at A14-2 increases to the point where it is more positive than the reference voltage at A14-3, the output at A14-7 switches toward positive. This time is approximately 100 microseconds and is considered as the default condition, where no clamp pulse was received to trigger the switching time.

5-74 When the negative transient pulse causes the output at A14-7 to go toward ground, transistor Q19 is brought out of conduction and the voltage at A14-3 becomes positive. As the voltage at A14-3 begins to rise exponentially, it increases to be greater than the reference voltage at A14-3 before the output at A14-7 switches toward ground. The clamp pulse, at the collector of Q16, is a positive-going pulse, which causes Q19 to conduct momentarily, lowering the reference voltage toward ground so that the exponentially rising voltage is made greater than the reference voltage.

5-75 The rising edge of the pulse at A14-7 is inverted at A13-6 to produce a trigger pulse for flip-flop A10.

5-76 The clamp pulses, mentioned above, are connected to the switcher/equalizer board through pin J22-R and are amplified in the two inverters labeled A12. The output at A12-9 is a square wave pulse whose negative-going edge causes the timing circuits of R69 and C26 to produce a negative-going transient pulse which causes transistor Q16 to go into cut-off. The collector of Q16 goes positive for the duration of the pulse. The positive voltage is connected to the base of Q19 through R72. When Q19 starts to conduct heavily, this pulls the reference voltage at A14-3 to ground.

5-77 The corresponding circuitry used for switching delay #2 operates in an identical manner to that of delay #1. This circuitry consists of inverter A13, transistors Q18 and Q22, differential comparator A15, and flip-flop A11. This circuitry operates to generate the alternate 90-degree switching

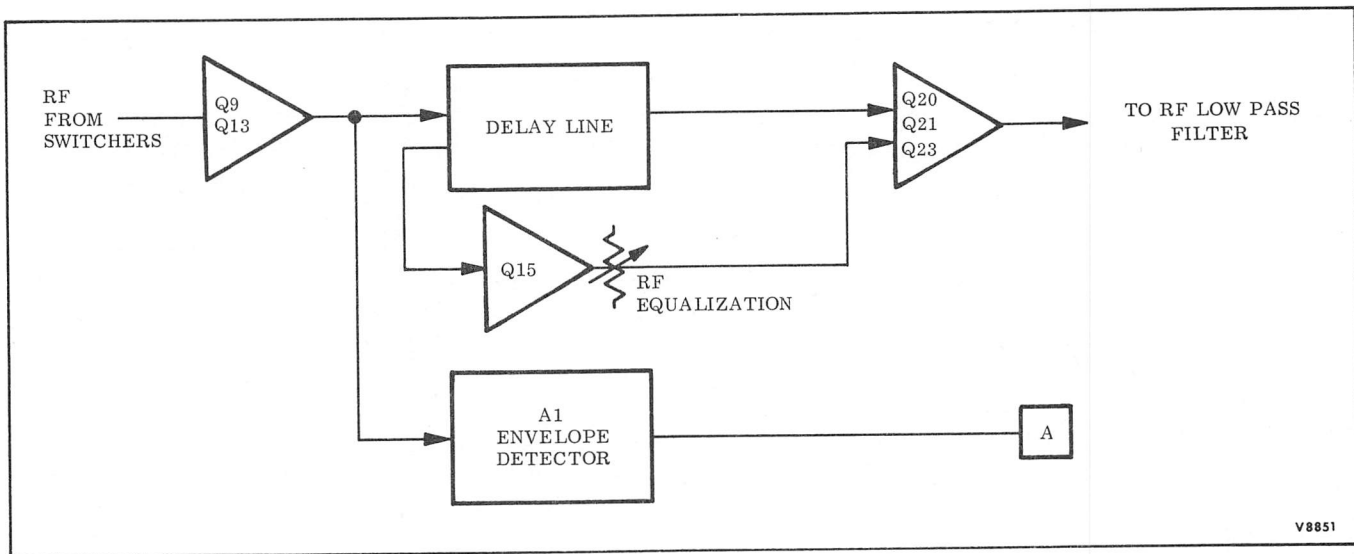


Figure 5-11. Cosine Equalizer and Envelope Detector Block Diagram

pulses. For this reason, the only difference in operation is a time delay of approximately 430 microseconds.

5-78 The combination of switching periods from delay #1 and delay #2, which are described above, provides alternate trigger pulses for flip-flops A10 and A11 respectively. These flip-flops alternately toggle to provide signals for the decoders consisting of the NAND gates A6, A6, A7 and A7. These decoding gates produce four gating signals for the switcher channel amplifiers. Outputs are available at A6-6, A6-7, A7-6 and A7-7.

5-79 The 1/A pulse is brought in to the switcher equalizer board at J22-15 and is used to preset all of the flip-flops in the playback switcher logic circuits, including the ring counter and logic gating flip-flops. This preset operation synchronizes the rotation of the head drum with the switching of the heads.

5-80 Transient suppression consists of keeping the reference voltage at A14-2 at ground potential until the delayed pulses at A14-2 or A15-2 cause the circuit to start the 100-microsecond timeout. The operation of Q19 is described as follows. The

feedback path, through R70 and C31, from the output of the comparator at A14-7 to the base of transistor Q19 causes the apparent sensitivity of the input at A14-2 to decrease (the input voltage must be greater to start the 100-microsecond timing cycle than the voltage to hold it). In its quiescent state, the output at A14-7 is at a positive potential. This is coupled back through the feedback components and causes Q19 to conduct heavily. The reference voltage at A14-3 is thus pulled to ground. This has the effect of requiring a greater voltage change at A14-2, which causes the voltage at A14-7 to switch. Noise transients are thus prevented from operating the head switching circuits.

5-81 COSINE EQUALIZER

5-82 The cosine equalizer circuit block diagram is shown in Figure 5-11. The cosine equalization of frequency response is provided for playback. The delay line is terminated in its characteristic impedance at the input end (at Q13) but unterminated at the output end. Therefore, the output end "sees" only the input signal, and the input end sees the input signal plus the reflection (standing wave) from the unterminated output. The delay line causes the reflection to

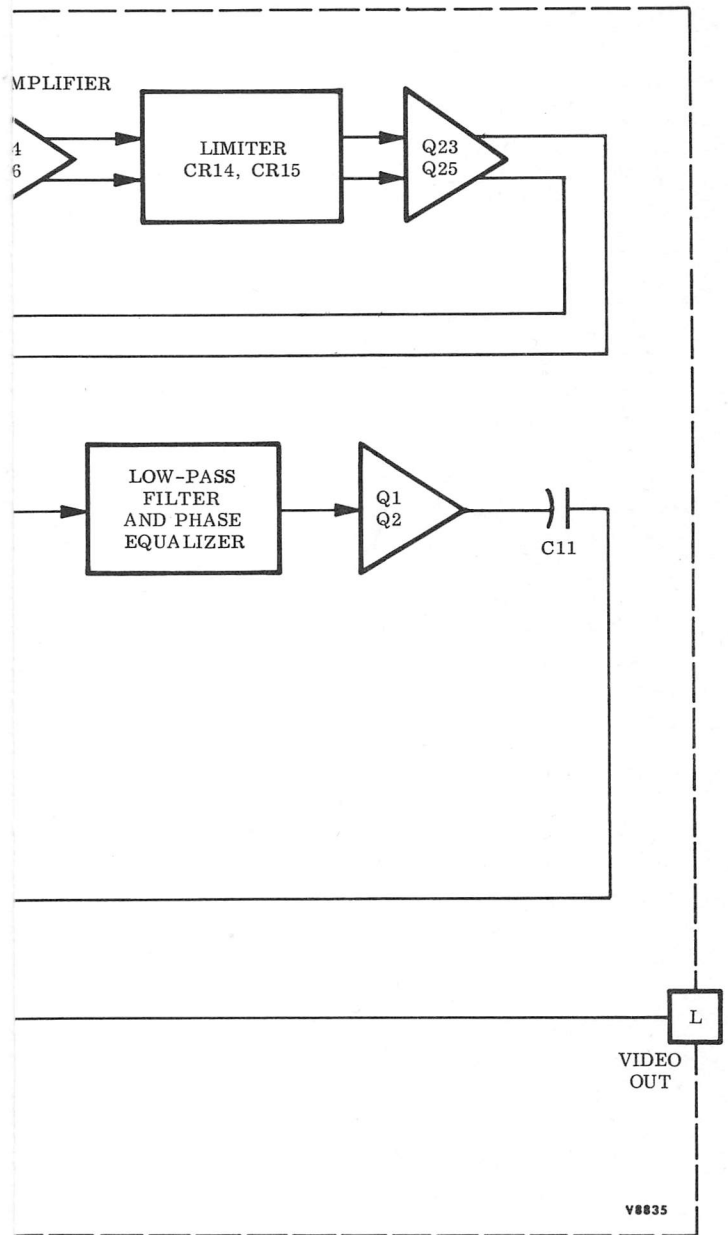


Figure 5-12.
Demod Filter Amplifier Block Diagram

appear at some time later than the original signal. The input signal to Q21 varies in amplitude as the cosine function of frequency.

5-83 Transistor Q9, shown in Figure 10-10, is an emitter follower driving the amplifier Q13. The input signal at the base of Q15 consists of the sum of the input signal to the delay and the reflected signal from the input end of the delay line. These two signals are mixed and appear as a combined rf signal at the RF EQUALIZATION potentiometer R79. At the same time, part of the signal leaves the delay line without being reflected. This signal is the input to the base of Q20. The delay of the rf signal through the delay line is in terms of phase angle. The output of the potentiometer slider (original signal and signal passing down and back through the delay line) is applied to the base of Q21. The signal from the delay line (passing through the delay line once) is applied to the base of Q20.

5-84 Transistors Q20 and Q21 form a differential amplifier. Emitter current for both Q20 and Q21 is supplied by the constant current source Q23. Consequently, the current drawn by one amplifier tends to decrease the current available for the other; the ratio of amplification between the two is set by R79, which controls the output level of Q21. As mentioned above, the two signals are derived by phase delaying and mixing. Thus, the amplitudes of the two signals and the respective phases determine the output amplitude of the mixed signal which is applied to C32. Depending on the setting of R79, up to 60 dB attenuation is possible at the low end of the frequency spectrum being used, and decreasing as the frequency is increased. The attenuation curve is similar in shape to a trigonometric cosine curve.

5-85 RF LOW PASS FILTER

5-86 The rf low pass filter (see Figure 10-10) consists of an LC, gaussian, linear phase network. This filter serves to limit the high frequencies of the rf spectrum.

5-87 ENVELOPE DETECTOR

5-88 The envelope detector (see Figure 10-10) consists of RF amplifier A1 feeding a peak detector CR1, CR2. The output, consisting of a test signal with varying level, represents the RF playback signals from each head and is used during the optimizing procedures.

5-89 DEMODULATOR FILTER AMPLIFIER (Board #23)

5-90 The demodulator filter amplifier consists of limiters, demodulator, low pass filter, phase equalizer, clamp/transient suppression, and output amplifier. A functional block diagram for this circuitry is shown in Figure 5-12, the schematic in Figure 10-7.

5-91 LIMITERS

5-92 In playback, tape rf from the rf switcher and equalizer is brought into the demodulator filter board through J23-V and coupled to the input amplifier Q12. Refer to Figure 10-7. Transistor Q14 serves as a phase splitter providing equal amplitude, opposing phase signals to the base elements of Q16 and Q15 respectively. Transistors Q16 and Q15 amplify the rf signal for limiting by the symmetrical limiters CR8 and CR9. The limited signal proceeds through three additional stages of amplification and limiting and appears at the base elements of Q19 and Q20. Transistors Q17 and Q18 serve as emitter followers to supply sufficient drive for the demodulator.

5-93 DEMODULATOR

5-94 The outputs at the emitters of Q17 and Q18 as shown in Figure 10-7 are coupled through two capacitors, C31 and the paralleled capacitances of C30, C34, to the tunnel diode multivibrator. Each zero crossing of the square wave input triggers the multivibrator to produce a pulse with a width of approximately 20 nanoseconds, factory adjusted by R39. This pulse is amplified by Q13 and fed to emitter follower Q11;

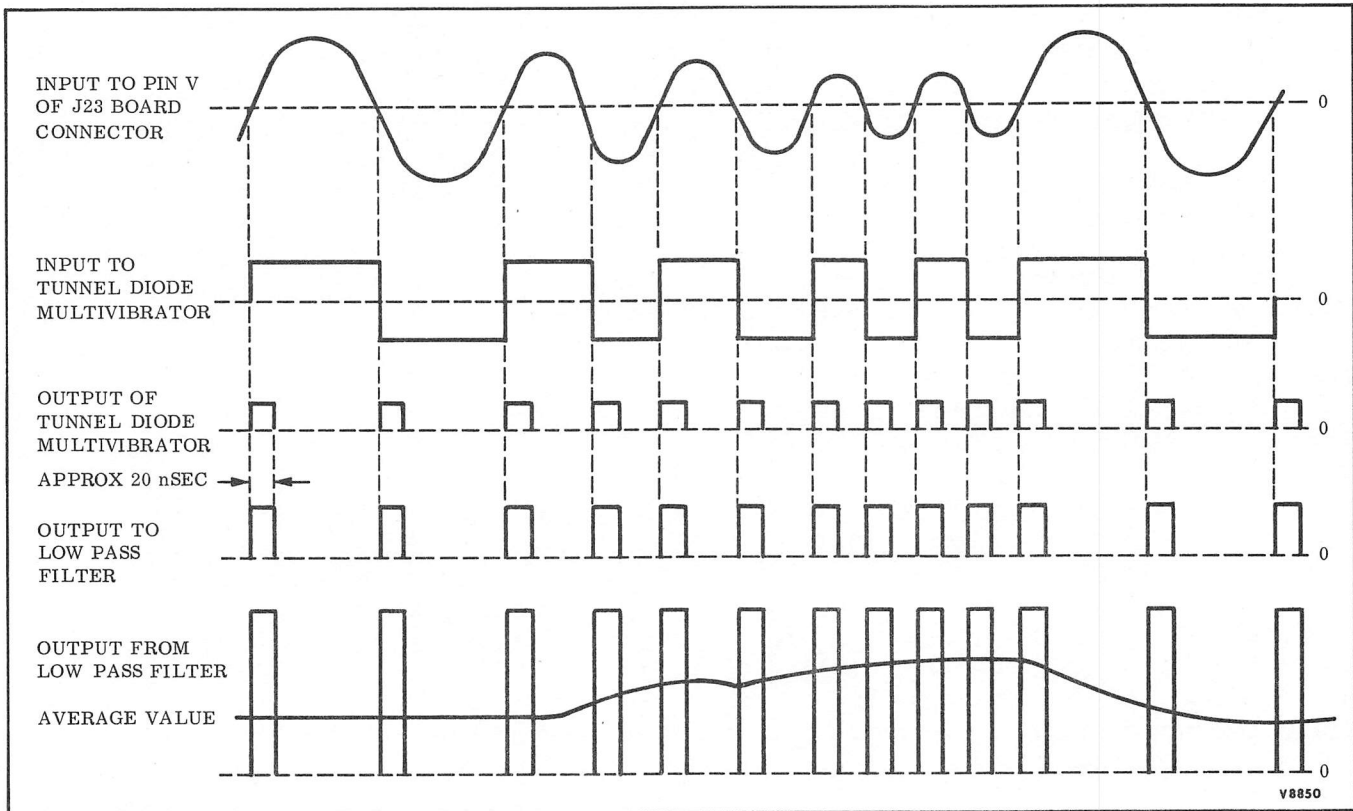


Figure 5-13. Demodulator Functions

transistors Q11 and Q13 are supplied with regulated operating voltage from Q10. The output of Q11 is coupled to differential switcher Q6 and Q9. The differential switcher is powered by constant current source Q24.

8-95 A pulse from Q11 drives Q9 into conduction. Transistor Q9 is turned off because all the available current from Q7 is passed through Q6. This action provides a positive-going output pulse at the collector of Q9. Figure 5-13 illustrates the relationship between the rf input signal, the limited signal at the input of the multivibrator, and the constant width-constant amplitude pulses at the output of the demodulator.

5-96 LOW PASS FILTER AND PHASE EQUALIZER

5-97 The low pass filter shown in Figure 5-12 filters out all rf components in the signal from the demodulator and integrates the

demodulator pulses to produce a voltage which is proportional to instantaneous peak rf.

5-98 Once the pulses are integrated, an output is obtained which is a representation of the pre-emphasized video signal in the modulator. The output of the low pass filter is fed through pin E1 to pin E3, on the board.

5-99 The phase equalizer is used to delay the higher video frequencies so that the overall response of the low-pass filter and phase equalizer is a uniform delay of all frequencies.

5-100 OUTPUT AMPLIFIER

5-101 The output of the phase equalizer and low-pass filter is used as input to the amplifier Q1. A response shaping network consisting of R2, R3, R4, C9 and C10 is included in the emitter circuit of Q1. Also,

the collector circuit of Q1 has a series inductance used as a peaking coil. The signal at Q1 collector is connected to the base of Q2. Transistors Q5 and Q8 serve as complementary emitter followers to provide the output signal at J23-L.

5-102 TRANSIENT SUPPRESSOR

5-103 Transistor Q4, when turned on, serves as a low-impedance shunt for the signal at the base elements of Q5 and Q8. This operation shorts the video signal to ground during head switching time. The clamp pulse, generated in the sync processing circuitry of the standards board, is connected to J22-R (switcher equalizer board), where it is delayed slightly in Q16. This pulse is used to trigger the head switching operation and also to supply blanking signals for the video. When the transient suppression pulse is positive, transistor Q4 conducts and pulls the video signal at its collector to ground.

5-104 BACK PORCH CLAMP

5-105 The video signal from the emitter follower Q2 is coupled through capacitor C11. Normally, the average dc level coupled through the capacitor is zero volts.

Transistor Q3 conducts for the duration of the clamp pulse (occurring during the back porch time) and clamps the junction of C11 and R8 to ground. Capacitor C11 either charges or discharges to assume an average dc level such that the blanking level is represented by a video signal of near zero volts (saturation voltage of transistor).

5-106 STANDARDS (Board #19)

5-107 The standards board consists of the pre-emphasis network, de-emphasis network, and sync processing circuitry, as shown in Figure 5-14. The pre-emphasis network is discussed previously and is shown in Figure 5-4 with part designations as listed in Table 5-4. The de-emphasis network and sync processing circuitry are discussed below.

5-108 DE-EMPHASIS NETWORK

5-109 The de-emphasis network is shown in Figure 5-15, with part values for the respective line standards listed in Table 5-5. Relay K1 allows the VR-3000 to be switched to either an A standard or B standard as described in Table 5-1. Each network provides the necessary de-emphasis response to fit a particular standard.

Table 5-5. De-Emphasis Network

Line Standard	R10 ohms	R8 ohms	R9 ohms	R2 ohms	R3 ohms	R1 ohms	C4 pf	C1 pf
525 HB	660	245	660	-	-	-	979.6	-
525 LB	-	-	-	78.7	555	555	-	335.2
625 HB	460.5	178.6	460.5	-	-	-	1345	-
625 LB	-	-	-	113	374	374	-	471.1
819 HB	460.5	178.6	460.5	-	-	-	1345	-
819 LB	-	-	-	113	374	374	-	471.1
405 LB	-	-	-	78.7	555	555	-	335.2

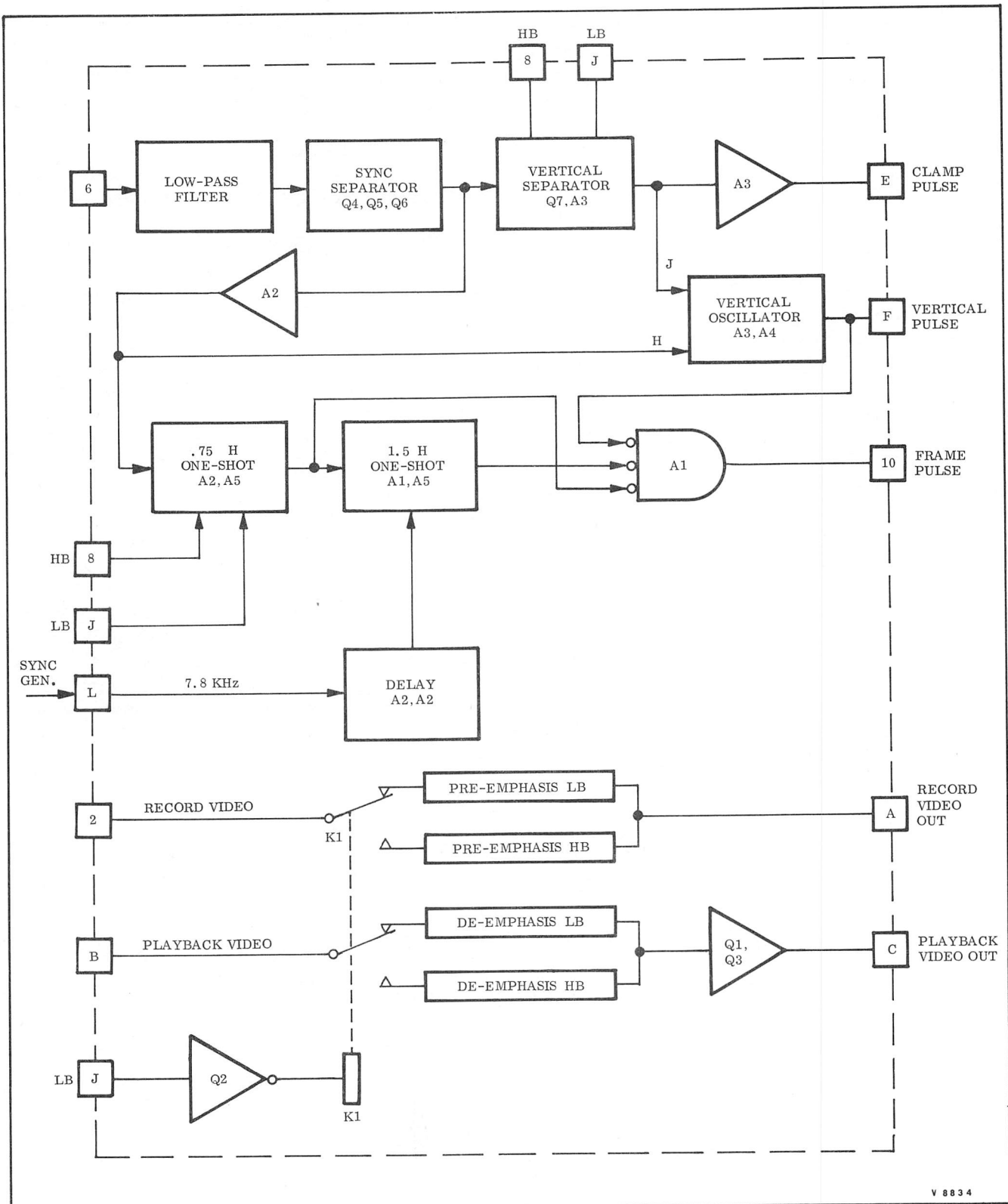


Figure 5-14. Standards Block Diagram

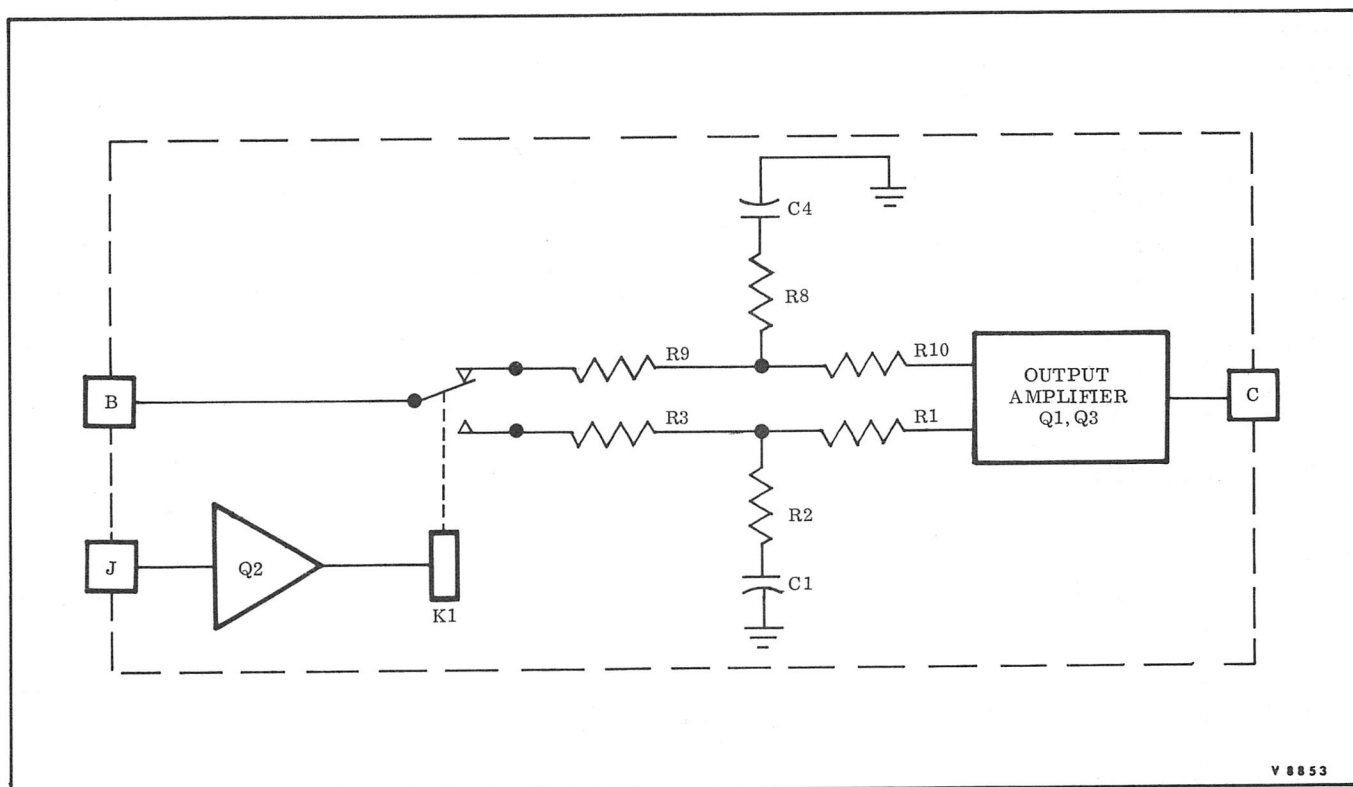


Figure 5-15. De-Emphasis Network

5-110 The presence of +12 volts at J19-B causes Q2 to conduct and operate relay K1 to select standard B. Absence of this voltage allows standard A to be selected. After de-emphasis, the video signal is amplified by emitter followers Q1 and Q3. Video output is at J19-C.

5-111 SYNC PROCESSING CIRCUITRY

5-112 Refer to Figure 5-16 for the block diagram. Because of the basic differences in the timing of sync signals within the various line standards, it is necessary to change the timing of the sync processing circuits. This is performed by the correct selection of the timing board, and selection of positions A or B of the STDS SELECT switch.

5-113 Composite video is routed to the standards board from the input output video board through J18-A and J19-6. Refer to Figures 10-2 through 10-6. The video at this point is approximately 4 volts peak-to-

peak, having negative-going sync. The signal is then filtered by the low-pass filter consisting of L1, C9, and C10. The low pass filter removes high-frequency noise and some video information. Sync amplifier Q4, Q6 clips the level of the signal and amplifies the sync pulses. Negative voltage excursions at the base of Q4 cause Q4 to conduct and pull its collector voltage toward the positive supply voltage. This causes Q5 to conduct more and its collector voltage is pulled toward the negative supply voltage. Because Q5 collector is made more negative, a current path is provided through CR14 to the base of Q6, and this current path discharges capacitor C14. Transistor Q6 acts as an emitter follower and tends to reduce the current flow in Q4, through emitter coupling. When the voltage starts to swing positive, after the sync pulse, the base of Q6 is held relatively negative and Q6 continues to conduct, drawing a large ratio of the available current through R20. Transistor Q4 cuts off very quickly, because insufficient emitter current is available. The

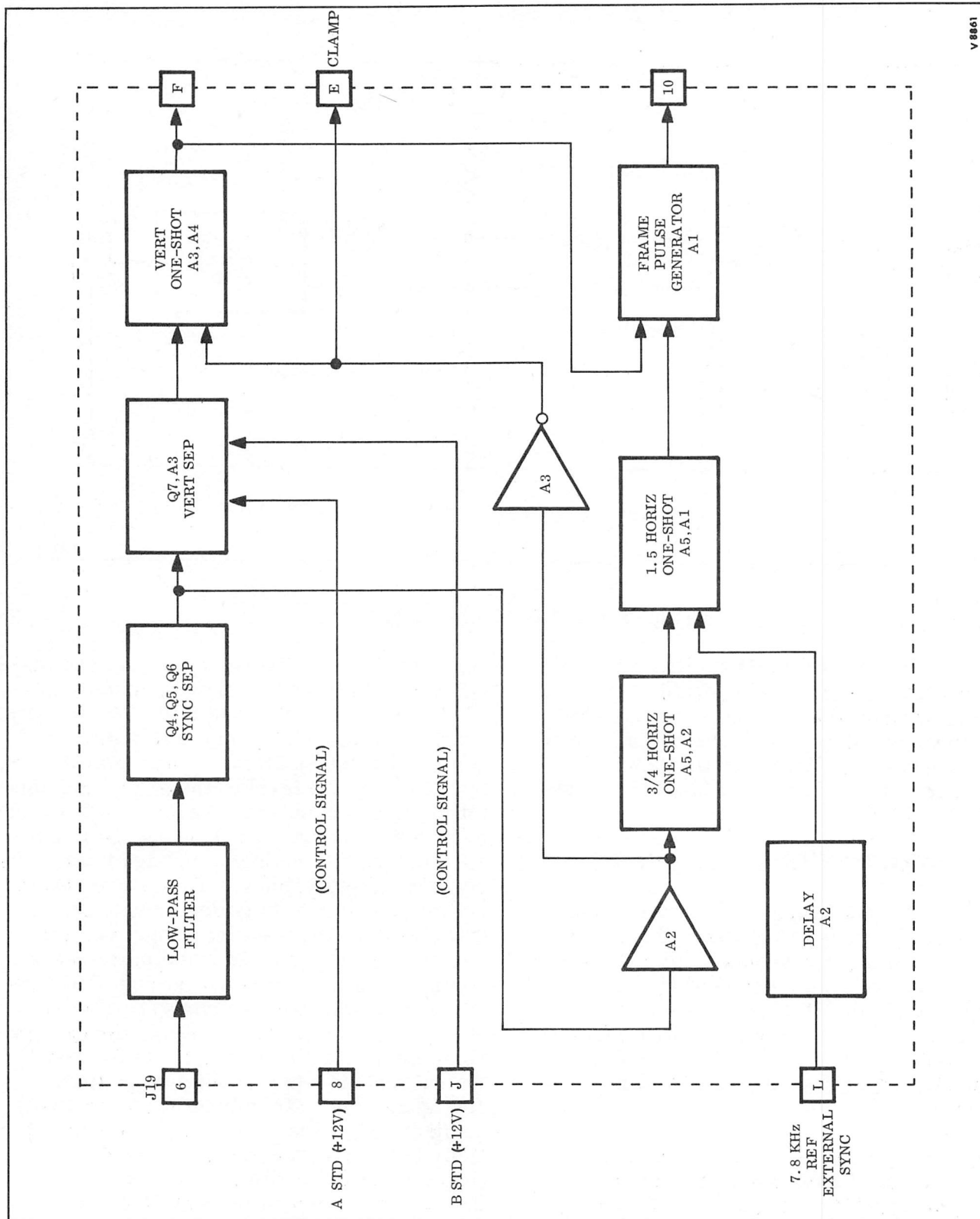


Figure 5-16. Sync Processing Block Diagram

negative-going voltage at the collector of Q4 causes the collector of Q5 to swing toward positive. This causes CR14 to become back-biased, so that the collector of Q5 cannot control the base voltage (and current) of Q6. Thus, the input composite video is stripped of all positive-going voltages, leaving only the negative-going sync pulses. The clipping ratio is defined by the resistance ratio of R36 and R37. The sync pulses, which are the most negative part of the composite video, are coupled into the base of Q7 and to the input of the inverter at A2-1.

5-114 VERTICAL SYNC SEPARATOR

5-115 Refer to Figures 10-2 through 10-6. With no input video, no sync pulses are produced and the collector of Q7 remains at ground potential because Q7 is normally conducting. When a sync pulse occurs, Q7 goes into cut-off and its collector is pulled toward the +12 volt supply. For this voltage to rise, capacitor C17 must be charged through the resistances supplied by the standard resistors R38 or R39. The time must be great enough for the voltage at A3-2 to rise so that the output at A3-8 can switch to ground. For horizontal sync timing, the on-to-off ratio of the sync pulse is not great enough for the output at A3-8 to switch. When the long vertical sync pulse occurs, the charging time is much greater than the discharge time through R42 and the output at A3-8 switches to ground.

5-116 The output at A2-9 is a positive-going pulse train, consisting of the sync pulses. Resistor R46 and capacitor C21 differentiate the sync pulses. The input at A4-1 is a series of voltage spikes, occurring at a horizontal rate, or during the vertical interval (including the equalizing pulses) occurring at twice the rate.

5-117 The output at A3-8 drops to ground potential between the leading edges of the vertical sync pulse and the first serration. This signal is the input at A4-2. The input

at A4-1 is the train of differentiated voltage spikes. The output at A4-7 is a series of positive-going pulses starting with the first serration of the vertical sync pulse and continuing until the termination of the vertical sync pulse. The NOR gate with output at A4-6 and the inverter with output at A3-9 serve as a 500-microsecond one-shot. The output at J19-F is a positive-going pulse.

5-118 Resistor R44 and capacitor C20 serve as a differentiator circuit to provide pulses at the input to the 3/4 horizontal one-shot. As the name implies, this one-shot produces a positive-going pulse with a duration of 3/4 h. The 1.5 horizontal one-shot also switches positive at the positive-going edge of the 3/4 horizontal pulse. The NAND gate with output at A1-4 provides the logic AND function, requiring that all three input signals from the 3/4 horizontal one-shot, the 1.5 horizontal one-shot, and the vertical one-shot, be at ground potential simultaneously in order for the output at A1-4 to be positive. This condition occurs during every other field and indicates a complete frame. The signal at J19-10 is referred to as the frame pulse.

5-119 VIDEO OUTPUT

5-120 Video output is available at the camera input connector so that the camera viewfinder may be used for monitoring playback. The de-emphasized video leaves the standard board through pin J19-C and is brought to the input output video board at J18-D. Refer to Figure 5-2 for the input output video, block diagram. Relay K2 is operated in the playback mode and the playback video is connected to the input at the base of Q1. Normally, the output video is taken from the MON VID OUT jack. This signal is provided through J18-E. If a camera using a crt type of viewfinder is used, a jumper is provided in the camera cable so that relay K1 operates in playback. This provides the video signal routing to the camera.

SECTION VI

SERVO SYSTEM AND CONTROL CIRCUIT THEORY

6-1 GENERAL

6-2 This section contains the theory of operation for the three servo systems and the control circuits of the Model VR-3000 Video Tape Recorder (VTR). The servo systems include the head drum servo, the capstan servo, and the reel servos. The control circuits include the operating controls, the control logic circuitry, and the tape guide actuation motor. The reel servos are considered as part of the control circuitry and are discussed under that heading.

6-3 SERVO SYSTEMS

6-4 The Model VR-3000 VTR records and reproduces television signals by transversely scanning a longitudinally moving tape with four rapidly rotating video heads. These heads are mounted in a precise quadrature on the periphery of a rapidly rotating head drum. Longitudinal tape speed must be controlled within standard tolerances. The head drum must rotate at a constant speed, also maintaining a standard maximum deviation tolerance, and at the same time the phase of the head drum must be rigidly controlled so that the tip of head #4 passes the center line of the tape at the instant that the vertical sync interval is half completed. This occurs at the center of the third serration of the vertical sync pulse.

6-5 Two similar servo systems are used to control the capstan speed and the head drum speed and phase. Figure 6-1 shows a simplified block diagram of the head drum servo, while Figure 6-2 shows a simplified block diagram of the capstan servo.

6-6 Each of these servo systems uses two control loops. In the head drum servo, one loop is used to control the speed of the head drum (first order loop); the second loop (second order loop) is used during record only to phase lock the head rotational phase to the vertical sync interval as described above.

6-7 Assume a condition where the head drum servo is rotating at the specified speed and is phase locked. As shown in Figure 6-1, the tachometer (6-tach) generates a signal with six pulses for each drum revolution. This tach signal is amplified and used as the input to the discriminator. The discriminator develops a dc voltage proportional to the speed of the head drum rotation. A voltage is developed in the drum speed reference circuit which is equal to the voltage from the discriminator when the drum speed is at its nominal value. These two voltages are compared in the comparator circuit; when they are equal, the output from the comparator is at zero volts. This is referred to as the drum error voltage. If the drum tends to slow, the discriminator voltage drops, and the output of the comparator circuit assumes a level and polarity such that the negative polarity indicates the slowing, while the amplitude of the error signal shows the degree of slowing. The amplifier-equalizer is used to amplify the error voltage and shape the response characteristics of the servo loop. The motor drive amplifier accepts the error signal and uses it as a reference to adjust the operating voltages to the motor, causing the motor to speed up.

6-8 Conversely, when the motor starts running faster, the discriminator output

voltage increases, the output of the comparator is now positive, and the motor drive amplifier reduces its output voltage to decrease the speed of the motor.

6-9 The second order feedback loop operates from an internal tachometer signal, which indicates drum rotational phase (1/A tach), and an external signal (vertical sync pulse information) to produce an error signal which indicates the degree of phase shift between the two signals. This second error is used as an input to the speed loop, as a vernier, to cause the first order loop to adjust the drum speed so as to bring the drum phase into line with the vertical input information.

6-10 The capstan servo is shown in the block diagram, Figure 6-2. Its operation is also in the form of a first order and a second order servo loop, and operates in a manner similar to that of the drum servo. During record mode the second order loop consists of

the record phase comparator which uses an accurate frequency source as a speed reference. During play mode, the second order loop consists of the play phase comparator, using a control track signal and a drum phase signal to generate the second order error signal for use in the speed loop.

6-11 HEAD DRUM SERVO

6-12 INTRODUCTION

6-13 The head drum servo block diagram is shown in Figures 6-1 and 6-3. The circuitry is located on the video head assembly, the MDA driver board (#16), the drum servo board (#15), and the motor driver amplifier board (#17). The circuitry is discussed in three functional groups: the motor driver, the rotational drum speed control, and the drum phase control.

6-14 Rotation of the drum is provided by an electronically commutated, dc motor,

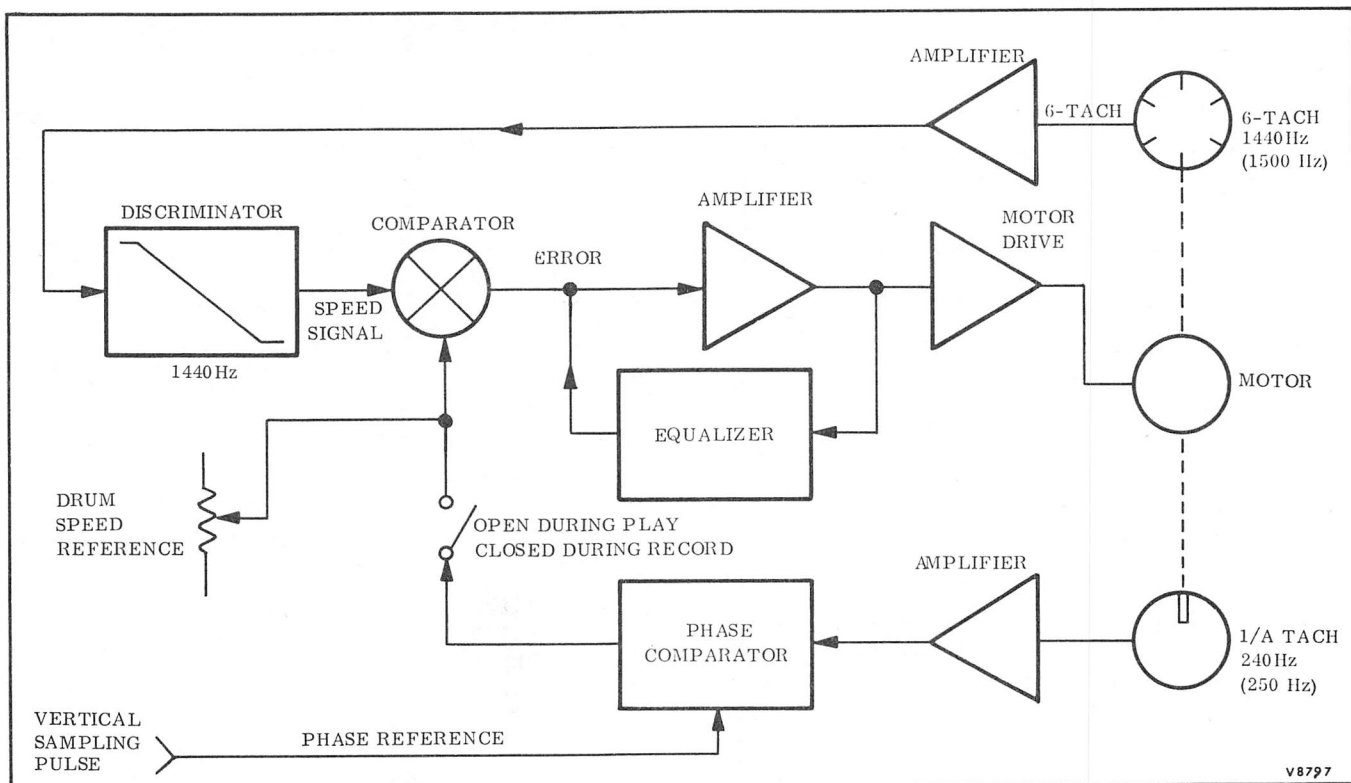


Figure 6-1. Head Drum Servo, Simplified Block Diagram

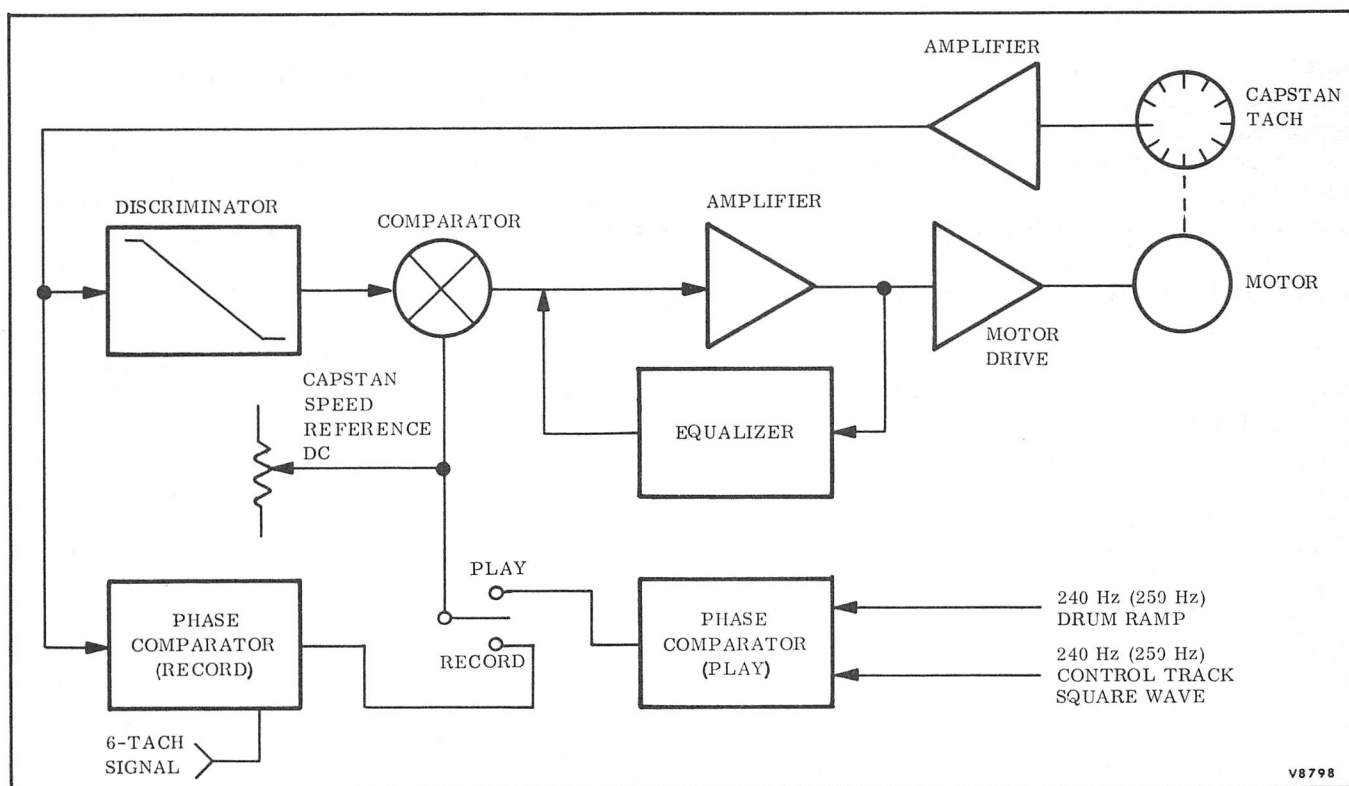


Figure 6-2. Capstan Servo, Simplified Block Diagram

more commonly referred to as a brushless motor. The video head assembly is described in Section IV of this manual. The tachometer disc which is attached to the motor shaft is designed to provide two types of information about the motor rotation: speed and instantaneous angular position (phase). The tachometer assembly generates two signals. One is a pulse which occurs once for each drum revolution and is referred to as the once around pulse (1/A). The tachometer disc is positioned on the motor shaft during manufacture so that the 1/A pulse occurs 5 h for 525/60 (305 μ s for 625/50) before the tip of head #4 passes the center of the tape. The head rotates at a 240 (250) revolution per second rate.

6-15 The second tachometer signal consists of pulses which occur at a rate of six pulses for each drum revolution. Each sixth pulse occurs slightly advanced in time with respect to the 1/A pulse. These six-around pulses are referred to as 6-tach pulses. Because the drum must rotate at a speed of

240 rps (250 rps), the outputs of the two tachometers are 240 pps and 1440 pps respectively (250 pps and 1500 pps). The 1/A pulse is used to generate motor phasing control signals; it is also used in other parts of the VR-3000 VTR. The 6-tach pulses are used to switch the electronic motor commutation circuitry, generate a drum speed signal for the speed control circuits, and provide drum speed signals to be used in other parts of the VTR.

6-16 MOTOR DRIVE CIRCUITRY

6-17 The motor drive circuitry is shown on the block diagram of the drum servo, Figure 6-3. The circuitry consists of the once around pulse generator, 6-tach pulse generator, starter, one-shot delay, shift counter, motor drive switchers, error amplifier, power amplifier, and power switchers.

6-18 Input power for the motor consists of three square wave, pulse trains bearing a 120° phase relationship. Switching of these

three voltages is controlled by the motor drive circuitry so that the timing and phasing of the switched voltages is correct for commutation of the motor field. Drum motor speed is controlled by varying the amplitudes of the three pulse trains. It should be noted that the field commutation is controlled by the position of the motor shaft.

6-19 The shift counter uses the 6-tach pulses as its switching signal and generates three output signals consisting of the square wave pulse trains. The timing waveforms for these signals are shown in Figure 6-4. Because the switching of the three motor input voltages must be phased with the rotation of the motor shaft, a synchronizing signal which consists of the 1/A pulse provides the initial phase. This presets the shift counter so that the motor field produced has a correct relationship with the motor shaft position to provide optimum forward torque. Each subsequent rotation of the motor shaft automatically maintains phase synchronization of the shift counter.

6-20 At initial turn-on, the individual flip-flops in the shift counter may assume either of two states, resulting in a set of static motor voltages which may produce forward, reverse, or, at certain shaft positions, no torque. To start the motor rotating, a starter circuit is used to generate a train of 5 pps pulses. These pulses are applied to the clock input of the shift counter as initial switching pulses in the absence of the 6-tach pulses. Once started, the motor automatically generates its own 6-tach pulses and the starter is turned off. If synchronized commutation is lost, the first subsequent 1/A pulse synchronizes the shift counter to the position of the motor shaft.

6-21 The outputs from the three stages of the shift counter are connected to the inputs of the associated motor drive switcher, located on board #17. Input voltage amplitude, for the motor, is controlled by the error amplifier and the power amplifier.

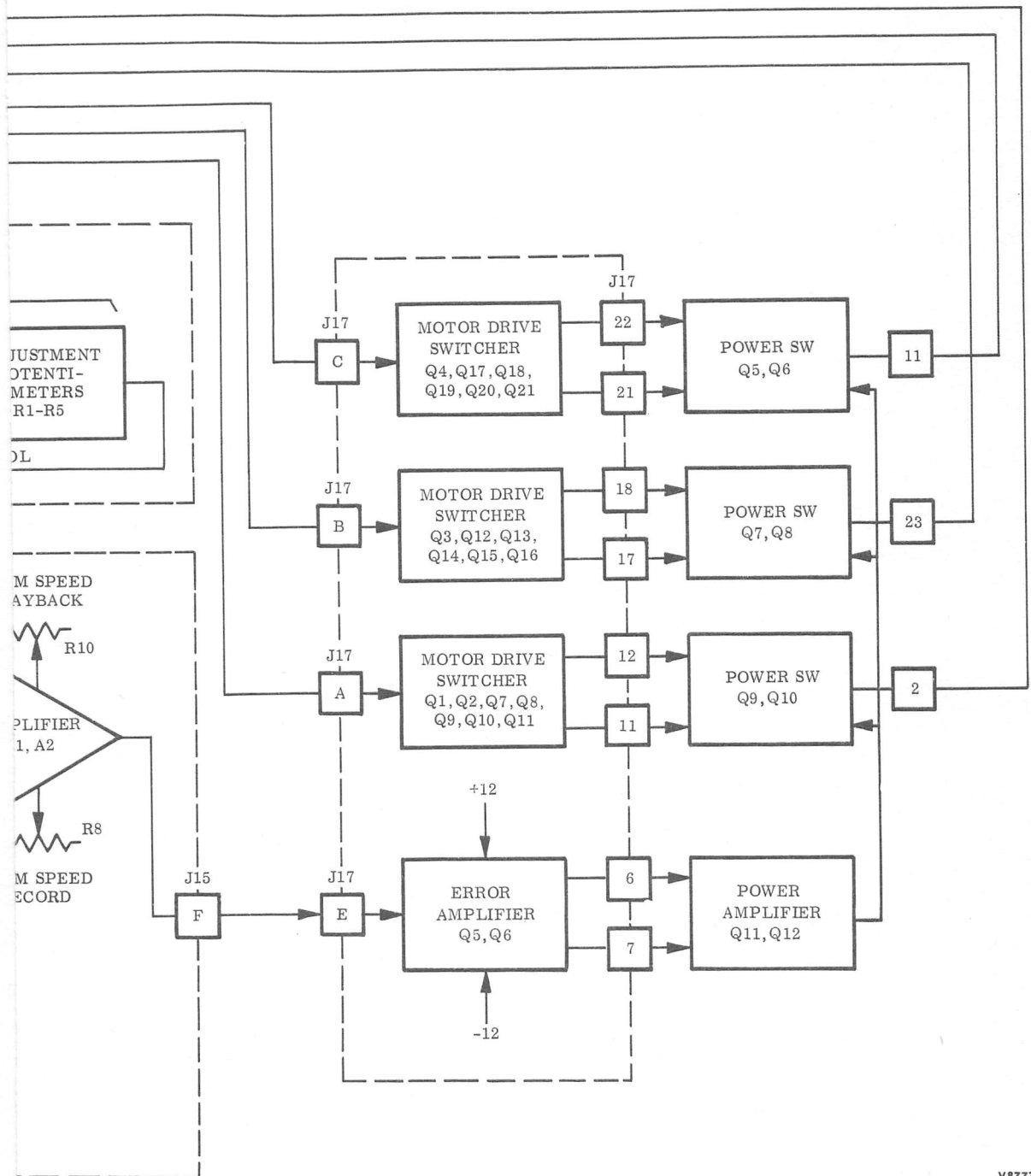
6-22 DRUM SPEED CONTROL

6-23 The drum speed control circuitry is shown on the block diagram, Figure 6-5. This circuitry consists of the tach time error cancellation circuits, the 1440 Hz (1500 Hz) discriminator, and the amplifier/equalizer circuit. Input signals for this circuitry consist of the 6-tach pulses and the output signals from each of the three stages of the shift counter. The output signal from this circuitry is an error voltage which is used as the input signal for the motor drive-error amplifier.

6-24 The tach time error circuits consist of decoding gates and transistor switches. This circuitry is located on Board #16. Adjustment potentiometers are located directly on the video head assembly. This circuitry is used to compensate for residual timing discrepancies which are introduced by production tolerances when the tach disc is manufactured. The potentiometers allow for each of five periods between the 6-tach pulses to be individually adjusted using the sixth period as a reference. Because the discriminator circuit uses the 6-tach pulses to generate the velocity signal, any variations in the periods between 6-tach pulses appears as an apparent increase or decrease in drum speed for which the drum servo would attempt to compensate, thereby introducing head velocity variations.

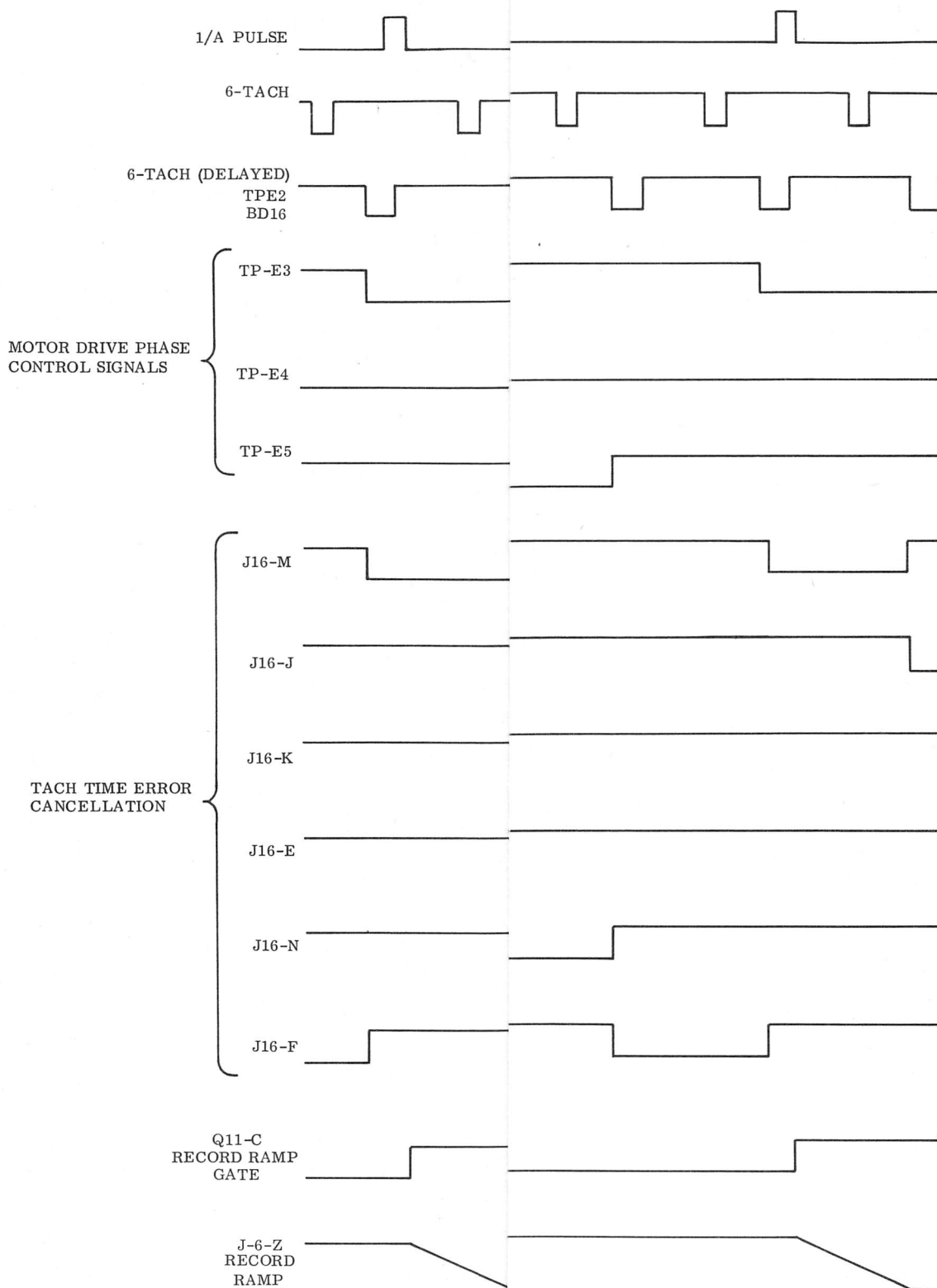
6-25 The time error compensated 1440 Hz (1500 Hz) signal is used as the input to the discriminator circuit located on board #15. Output from the discriminator circuit is a voltage which is proportional to the speed of the tachometer disc and thus of the drum

6-26 The amplifier-equalizer consists of two operational amplifiers. The first is connected as a differential comparator with the speed voltage from the discriminator as one input and a reference voltage as the second input. The output of the first comparator is a speed error voltage. This error voltage is used as one input to the second operational



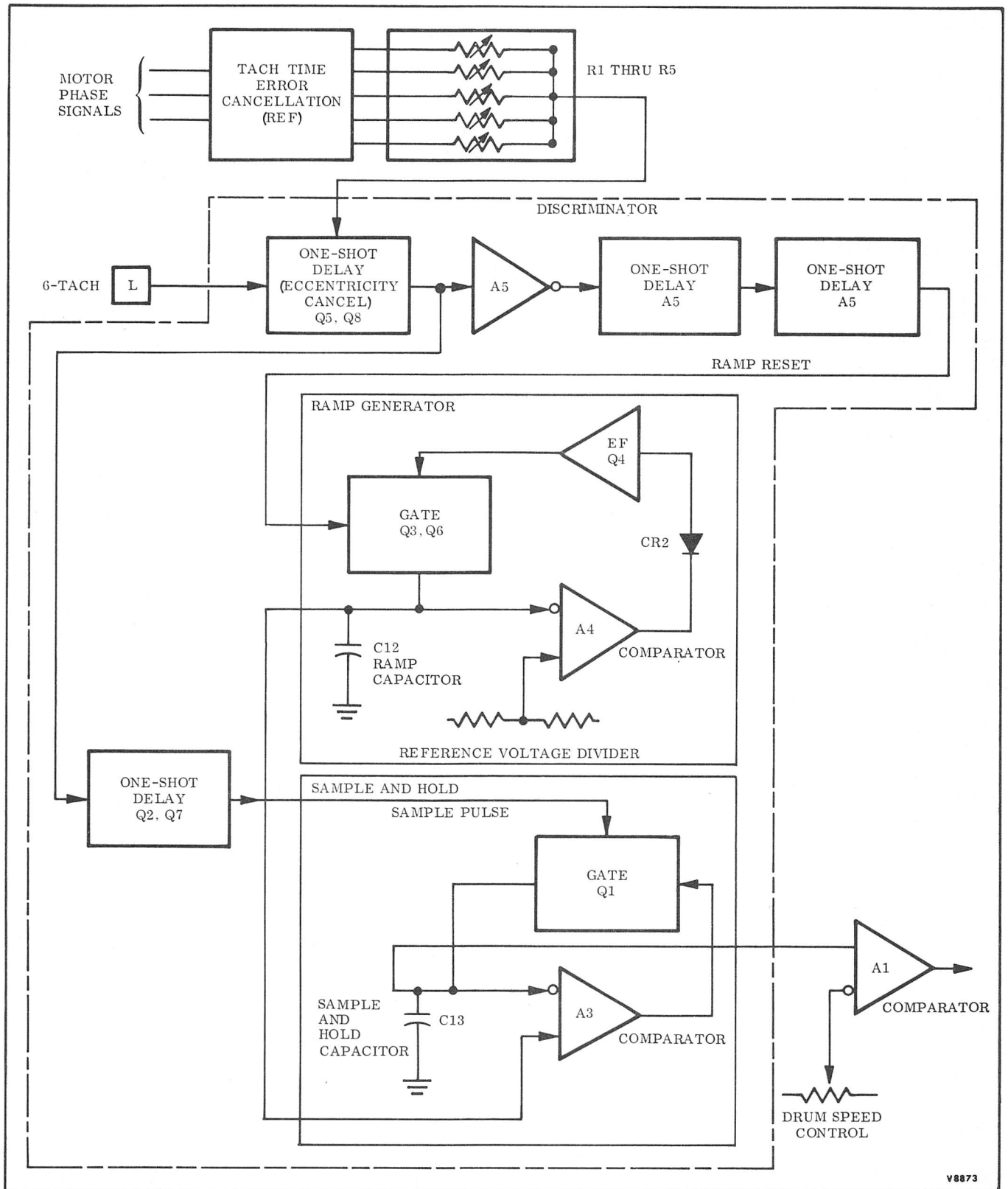
V8777

Figure 6-3. Head Drum Servo, Functional Block Diagram



V08784

Figure 6-4. MDA Timing Waveforms



V8873

Figure 6-5. Drum Speed Control, Block Diagram

amplifier. The other input to the second operational amplifier is the output of the phase comparator circuit. The response curve of the second operational amplifier is shaped in such a way as to optimize the stability and transient response of the drum servo loop.

6-27 DRUM PHASE CONTROL

6-28 The drum phase control circuitry is shown on the block diagrams of the drum servo, Figures 6-1 and 6-3. The circuitry consists of the record ramp generator, the vertical phase comparator, and the record phase error amplifier. The record ramp generator accepts a drum phase pulse which is generated as a result of signals from the decoder in the tach time error cancellation circuitry. A ramp is generated which starts 5 H on 525/60 line standard systems (305 μ sec on 625/50 systems) before the tip of head #4 passes over the center line of the tape and decreases voltage from approximately 5 volts to zero volts. A vertical sampling pulse is generated from the input video board, and is started at the first serration of the vertical sync pulse of the input video. The trailing edge of the vertical sampling pulse occurs at the halfway point of the vertical sync pulse. The vertical phase comparator accepts the ramp signal and gates it with the vertical sampling pulse in a sample and hold circuit. The phase relationship between the ramp and the sampling pulse is used to generate a voltage which varies as a function of the time difference between the occurrence of vertical sync and the passage of head 4 across the center of the tape.

6-29 DRUM MOTOR

6-30 The drum motor is an integral part of the rotary head assembly and consists of a brushless motor. The field winding of the motor is divided into three segments, each wound in delta configuration at an angular displacement of 120°. To maintain the operating torque in a forward direction, the field is advanced in step with motor rotation. This commutation of the field is accomplished by switching input voltages between

three input connections in such a way that two connections are either positive or grounded while the last connection is at the complementary condition of the other two. In this way, the currents in the three field windings are commutated and the field rotates in step with the rotation of the motor shaft.

6-31 Commutation of the input voltage to the motor is performed by the circuitry on the MDA board #16, and the motor drive amplifier board #17. The field is advanced six times, in steps of 60° for each rotation. The 6-tach signal is used to control the timing of the field commutation.

6-32 SIX-TACH

6-33 The 6-tach signal is developed from a tachometer assembly which is attached to the motor shaft. The tachometer disc consists of a circular piece, with six radial slots machined into the disc. One of the slots is longer, extending further toward the hub than the remaining five slots. Two pickup heads are attached to the tachometer housing so that one is placed over the portion of the disc where all six slots pass and the other is placed in a position where only the longer slot passes. The six slot pickup head generates the 6-tach pulses while the single slot pickup head produces the 1/A pulses.

6-34 ONCE AROUND PULSE GENERATOR

6-35 The once around (1/A) pulse generator is located on board #16 and consists of high speed differential comparator A14 and operational amplifier A12. This circuit is shown in the schematic, MDA driver, Figure 10-21. The 1/A pulse from the tachometer pickup has an amplitude of approximately 4 to 6 volts peak-to-peak and a pulse rate of 240 pps (250 pps). This signal is used as the input to A14-2. The inverting input to the differential comparator at A14-3 has a slightly negative voltage, which is the result of the voltage divider consisting of resistors R23 and R24. This negative voltage is introduced to provide noise immunity. The

output at A14-7 is a square pulse with its time reference for switching being the zero crossing of the input signal. Operational amplifier A12 amplifies the positive portions of the pulse and provides a zero output voltage for negative input portions. The output at A12-5 is a positive going pulse with an amplitude of approximately 1.7 volts and a pulse width of approximately 140 microseconds.

6-36 SIX-TACH PULSE GENERATOR

6-37 The 6-tach pulse generator is located on board #16 and consists of differential comparator A2 together with the inverters labelled A3. This circuit is shown in the schematic, Figure 10-21. Input from the six-around tachometer head is connected through J16-A to the input of A2-3. The input at A2-2 is a slightly negative voltage which is produced in the same manner as the noise immunity voltage in the once around circuit. This voltage also serves as a noise immunity offset.

6-38 The positive going output signal is used as inputs to the inverters A3-3 and A3-4. The outputs of these inverters, at A3-7 and A3-6 are inverted, positive going 6-tach pulses.

6-39 ONE SHOT DELAY (6-TACH)

6-40 The one shot delay circuit is located on board #16 and consists of transistors Q1 and Q4, and differential comparator A1. This circuit is shown in the schematic, Figure 10-21. This one shot delays the 6-tach pulses which are used as trigger pulses to the shift counter. This allows the tach time error compensator circuits to operate in time with the shifting of the shift counter.

6-41 Signal input consists of the 6-tach pulses generated at A2-7. In the quiescent state, the voltage at A2-7 is slightly negative, making the voltage at the base of A1 slightly negative. Transistor Q1 is cut-off. Capacitor C1 is charged by the current through resistor R3; the maximum charging voltage is +4.2 volts because of the clamp

diode CR1. The voltage at A1-3 is established by potentiometer R1, which serves as the 6-tach (trigger) time delay adjustment.

6-42 When the 6-tach pulse occurs, the base of Q1 goes positive and the transistor conducts heavily, discharging capacitor C1 through resistor R10. At the termination of the 6-tach pulse, Q1 goes into its quiescent state and capacitor C1 charges through R3. If the input voltage at A1-2 is more positive than the voltage at A1-3, the output at A1-7 is positive. This is the case during the quiescent period, just before the 6-tach pulse occurs. The output at A1-7 is positive and the transistor Q4 conducts heavily; the voltage at the collector of Q4 goes to near ground potential. When the 6-tach pulse occurs, the voltage at A1-2 moves at an exponential rate toward the 12 volt level. The output at A1-7 is negative until the charging voltage at A1-2 is equal to the voltage established by R1 at A1-3, at which time the output voltage swings positive. Because Q4 starts conducting heavily, its collector is pulled to ground potential. Diode CR1 serves as a clamp, to prevent the voltage being applied to A1-2 from exceeding +4.2 volts during its positive excursion.

6-43 The voltage at the collector of Q4 goes positive when the 6-tach pulse starts and returns to ground potential after the period defined by the charging of capacitor C1 to the voltage level which is set by R1.

6-44 SHIFT COUNTER

6-45 The shift counter is located on board #16 and consists of three J-K flip-flops connected as a shift counter. Two NOR gates, with outputs at A11-6 and A11-7, are used to provide the six-count feedback necessary to reset the counter at the count of six, without introducing any spurious counting modes. The shift counter changes state at the instant of the negative going trailing edge of the delayed 6-tach pulses which are applied to the toggle input of each of the shift counter stages. Synchronization of the shift counter with the motor shaft position is provided by presetting

the shift counter with the 1/A pulse. The outputs of the shift counter stages are 50% duty cycle square wave signals at the revolution rate of the motor.

6-46 STARTER

6-47 The starter is located on board #16 and consists of the circuitry associated with transistors Q2 and Q3 and diodes CR2, CR3 and CR4. When the 6-tach pulses are present at A3-6, capacitor C5 couples the pulse train to the peak rectifier CR3, CR4. The positive voltage developed this way is used as input to the base of transistor Q3. Unijunction oscillator Q2 becomes disabled; no starting pulses are generated. In the absence of 6-tach pulses, no positive voltage is developed and the unijunction oscillator functions to produce a 5-pps pulse train. These pulses are coupled through diode CR2 to the input of the 6-tach one shot delay circuit.

6-48 MOTOR DRIVE SWITCHERS

6-49 The motor drive switchers are located on board #17 and on the main chassis. Three separate signal paths are used to switch the three inputs to the brushless motor. The circuitry for each path is similar. The circuit is shown on the motor drive amplifier head drum schematic (Figure 10-24). For description purposes, the three signal paths are referred to as channel A, channel B and channel C, depending on the source of input signal (the pin numbers of J17 are used as the designation). Because the three channels are similar, only channel A is discussed (input at J17-A).

6-50 The circuitry for the motor drive switchers is located at two places in the VR-3000, the motor drive amplifier board J17 and on the chassis, directly beneath the J17 board. The input signal for channel A is routed from J17-A to the base of transistor Q2. The collector of Q2 is connected to the base of transistor Q9. Transistors Q7 and Q10 are emitter followers, using the signal from the collector of Q9 as their inputs. Transistors Q8 and Q10 are connected as a Darlington Pair; transistors Q7 and Q11 are also connected as a Darlington Pair and conduct on a complementary basis with Q8

and Q10. When the input at J17-A is positive, chassis-mounted transistor Q9 conducts and chassis-mounted transistor Q10 is cut off. Conversely, when the input at J17-A is a ground potential, Q9 is cut off while Q10 conducts. Transistors Q9 and Q10 (mounted on the chassis) are power switches and alternately switch the positive battery voltage and a variable negative voltage to the associated winding of the drum motor (connected through J17-2).

6-51 Transistor Q1 on the J17 board is a current-saving control device. In standby, when the head drum motor is not used, to conserve power, the current paths Q11-R20, Q16-R33, and Q21-R46, which are returned through Q1 to ground, are opened by having Q1 at cutoff. Only when the vacuum pump motor is energized, the input at J17-5 has a positive voltage which causes transistor Q1 to conduct heavily. The collector of Q1 acts as a low impedance path to ground for the return currents of transistors Q11, Q15, and Q21. An additional feature obtained by connecting the current saving transistor circuit to the vacuum pump enable line instead of to the motor enable line is that pump operation is maintained for five seconds longer than the head motor drive signals, after the head drum drive signal is turned off. A current path is thus maintained to dissipate back emf from the motor, and consequently drum rotation ceases more quickly.

6-52 MOTOR DRIVE CONTROL AMPLIFIER

6-53 The motor drive control amplifier is located on board J17 and on the chassis. The circuitry is shown on the motor drive amplifier head drum schematic (Figure 10-24). Transistors Q5 and Q6 are emitter followers which use the amplified drum velocity error signal as input. The two signals are then connected to the bases of transistors Q11 and Q12 on the chassis. Q11 and Q12 are connected as a complementary emitter follower pair. As the voltage which is generated from the drum speed error circuitry changes, the output at the junction of transistors Q11 and Q12 changes. Each channel of the switching motor voltage

switches between the positive battery voltage and the output of the emitter follower pair Q11 and Q12. The voltage differences between the three inputs to the motor appear across the related windings. If the motor tends to slow, this is sensed by the servo loop, which responds and makes the controlled voltage more negative. The voltage difference across the motor winding is then greater and the motor tends to speed up. Diodes CR2 and CR3, at the inputs to Q5 and Q6 on board J17, are always forward biased and minimize any crossover distortion. Zener diode VR1 serves to offset the input voltage to Q5 and Q6 so that the quiescent voltage at the output of the error amplifier A2 on board #15 is near zero volts.

6-54 TACHOMETER TIME ERROR CANCELLATION

6-55 The tach time error circuitry is located on the MDA driver board #16. The circuitry is shown on Figure 10-21. Potentiometers are included in the rotating head assembly for adjustment of 6-tach timing errors inherent in the respective drum tach disc.

6-56 The outputs from the shift counter are used as inputs to the decoding gates consisting of inverters A3 and A7, and NOR gates A4, A5 and A6. The outputs of these gates at A4-6, A4-7, A5-6, A5-7, A6-6, and A6-7 are pulses which occur consecutively at each gate output for each change of state of the shift counter. The six outputs bear a timing relationship to each other so that one of the pulses is on while the others are off; each pulse is on for only 60° of drum rotation. Figure 6-4 shows the timing and phase relationship between the six output lines. Transistors Q5 and Q9 are switches to provide low impedance paths to ground. Each transistor effectively grounds the return for one of the adjustment potentiometers.

6-57 Time error compensation is performed by sequentially inserting each of these potentiometers, during each rotation of the head, into a time constant circuit in the variable delay one-shot consisting of Q5

and Q8, on board J15. In this manner, the trailing edge of each of the five 6-tach pulses may be adjusted with respect to the fixed time delay determined by fixed resistor R42. These adjustments are performed at the factory during manufacture of the head.

6-58 DISCRIMINATOR (1440 Hz or 1500Hz)

6-59 The discriminator is composed of the circuitry, A5, Q6, Q3, Q4, A4, A3, Q1, Q2 and Q7, located on the drum servo board, J15. The circuitry is shown on schematic, Figure 10-22, and functional block diagram, Figure 6-5.

6-60 The time delay Q5, Q8 is used to compensate for non-uniformities in the manufacture of the tachometer disc. Without compensation, the 6-tach pulses occur at an average rate of 1440 (1500) pps, but the individual periods between pulses may not be exactly equal. The variable time delay adjustment is adjusted to have equal periods of time between consecutive trailing edges of the 6-tach pulses which are used as input for the discriminator when the motor is turning at constant angular speed.

6-61 When the leading edge (positive going) of the 6-tach pulse occurs, transistor Q5 conducts and its collector voltage moves toward ground potential. This negative voltage excursion is coupled through capacitor C19 to the base of Q8. The collector of Q8 goes positive, toward the +3.6 volt supply. Transistor Q8 is normally conducting and the negative transient coupled through C19 causes it to cut off. Capacitor C19 is then charged through the time constant circuit consisting of R49, R40 and the selected resistor in the tachometer time error compensator. When the capacitor is charged, the transistor again conducts and the collector voltage drops to near ground potential.

6-62 The pulse produced at the output of Q8 is connected to the input of inverter A5-1. The output is at A5-9, in an inverted state. Inverter A5 with output at A5-8 complements the pulse a second time. Capacitor C21 and resistor R47 together with A5 comprise a

boxcar one-shot with output at A5-7. This circuit produces a positive-going pulse occurring at the trailing edge of the pulse at A5-8 and having a pulse width of approximately 4.5 microseconds. Components C20, R46 and A5 produce a positive-going pulse at A5-6, occurring at the trailing edge of the 4.5 microsecond pulse and having a pulse width of approximately 30 microseconds. The pulse at A5-6 is used to reset the ramp circuit of the discriminator.

6-63 The ramp signal is generated in the circuit consisting of Q6, Q3, Q4, A4, and charging capacitor C12. Immediately following the ramp reset pulse, described in the paragraph above, capacitor C12 begins to discharge from 5 volts toward ground potential, through resistor R27. At the occurrence of the next 6-tach (delayed) pulse at A5-6, transistor Q6 conducts, causing transistor Q3 to saturate. Transistor Q4 is an emitter follower; the voltage at its emitter is approximately 5 volts. The ramp capacitor C12 is charged to +5 volts, through resistor R26. This circuitry is referred to as the reference loop because the reference voltage is defined in this circuit.

6-64 The reference voltage is developed across the zener diode VR2 and is connected across the voltage divider consisting of R29 and R31. This voltage, at the junction of R29 and R31, is approximately 5 volts and is connected to the input of the operational amplifier A4 at A4-3. If the peak voltage across capacitor C12 exceeds +5 volts, the output at A4-6 becomes negative and capacitor C17 discharges through the path provided by diode CR2, resistor R32 and the low impedance path to ground at A4-6. This cycle occurs only when the peak of the ramp exceeds the +5 volt reference level, making the discharge time of C17 last only for a part of the ramp cycle. This partial discharge of C17 serves to decrease the average voltage at the emitter of Q4 in order to have a long time constant voltage representing the peak ramp voltage, near the reference voltage. The loop is closed only during the reset pulse, and C17, R33, and R39 constitute a long time constant to maintain the

proper voltage for the succeeding pulses. Because diode CR2 only allows discharging of capacitor C17, an offset is provided by R39 and R33, causing an error voltage which is always in the positive direction, producing pulses at the output of A4-6.

6-65 The sequence of events in the ramp circuit is as follows:

- a. The 30-microsecond pulse occurs at Q6 collector and causes the voltage across capacitor C17 to be +5 volts.

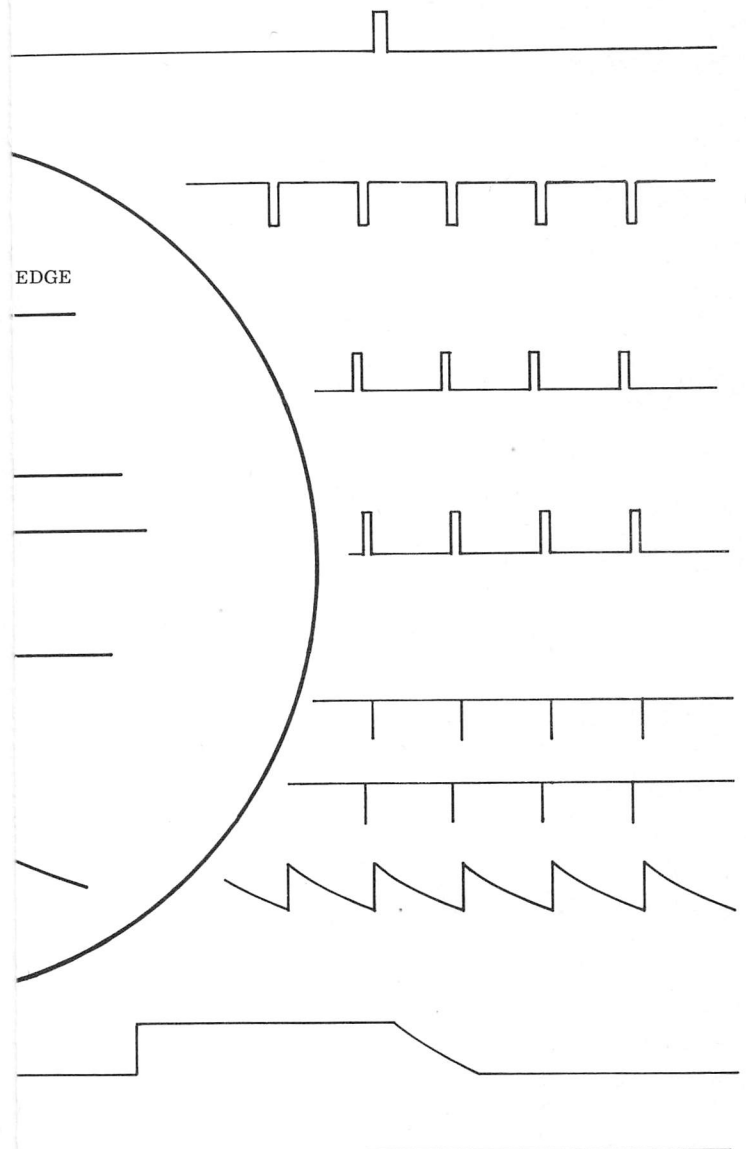
- b. At the completion of the 30-microsecond pulse, capacitor C17 starts to discharge toward ground at an exponential rate.

- c. At the next tach pulse, the 3-microsecond sample pulse is generated and applied to a sample-and-hold circuit. The output of the sample-and-hold circuit is a dc voltage which is the voltage of the ramp at the instant of the dropping edge of the 3-microsecond sampling pulse.

- d. After an additional 4.5-microsecond delay, a new reset pulse is generated (30-microsecond pulse) for a new cycle.

6-66 The occurrence of the 6-tach pulse at the collector of Q8 also causes transistor Q7 to conduct heavily. Transistors Q2, Q7, together with capacitor C8 and resistor R35, form a boxcar one-shot circuit. Transistor Q2 also conducts heavily, but its output does not change because it is already conducting. At the trailing edge of the 6-tach pulse at Q8-collector, Q7-collector swings positive and a positive transient is coupled through C18 to the base of Q2, cutting it off; the collector of Q2 swings negative. When C18 is charged, through R35, the collector swings positive again. The pulse is a negative-going, 3-microsecond output at Q2-collector.

6-67 Operational amplifier A3 and transistor Q1 act as a sample-and-hold circuit. When the loop is closed, through transistor Q1, the voltage at A3-2 is made equal to the



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Figure 6-6. Drum Speed Control
Timing Waveforms

voltage at A3-3. At the end of the sample pulse time, the loop is opened and the voltage is held as a charge on capacitor C13. The output is a dc level if no frequency change occurs, or a varying voltage changing at a rate of the speed change. Figure 6-6 shows the timing relationship between the ramp, sampling, and reset pulses. The exponential discharge rate of capacitor C12 approximates an inverse-period curve over the frequency of interest. The sample-and-hold circuit maintains the voltage level which is sampled during the sampling pulse time. This voltage is proportional to the frequency of the 6-tach pulses, which is numerically equal to six times the speed of the drum motor in revolutions per second.

6-68 AMPLIFIER EQUALIZER

6-69 The amplifier equalizer consists of the operational amplifiers A1 and A2, and is located on board #15. Amplifier A1 is connected as a differential comparator. The output of the discriminator is compared with a reference voltage. The voltage is adjusted with R8. The difference is amplified by A1 and A2 and the output is used to control the motor speed in such a way as to minimize the difference at the two inputs of A1.

6-70 In record mode, the output of the A6 record phase error amplifier is summed with the signal at the reference voltage input. This is performed in the circuitry associated with the amplifier equalizer, namely R15 and R21. This introduces the phase lock loop.

6-71 RECORD RAMP GENERATOR

6-72 The record ramp generator consists of the J-K flip-flop A13, transistor Q11, Q12, and Q13, and the operational amplifier A15, all located on the MDA driver board J16. The circuitry is shown in the schematic, Figure 10-21.

6-73 The record ramp is used by the sample-and-hold circuit in the vertical phase comparator as a once-around ramp, starting

5H before head #4 tip passes the center of the tape, and lasting for approximately 5H after the tip passes the center of the tape, on 525/60 line standard systems (305 μ sec on 625/50 systems).

6-74 The record ramp starts at the trailing edge of the 1/A pulse. The J-K flip-flop is preset by the output of A7-9. This is shown on the waveform timing, Figure 6-6. Transistor Q11 normally is in the conducting state, causing Q13 to conduct heavily. The loop from A15-6, through Q13 and Q12, back to the input at A15-2, is closed. In a manner similar to that used in the discriminator circuit, the voltage at A15-2 is brought to a level established by the voltage divider R36-R37.

6-75 When the trailing edge (negative-going) of the 1/A pulse occurs, Q11 and Q12 stop conducting because the J-K flip-flop is reset by this dropping pulse edge. Capacitor C12 begins charging toward the -12 volt supply voltage through R26. Diodes CR5 and CR6 limit the negative voltage excursion to approximately 0 volts.

6-76 VERTICAL PHASE COMPARATOR

6-77 The vertical phase comparator circuit consists of transistors Q10 and Q12 through Q18. This circuitry is located on the drum servo board #15.

6-78 The once-around, record ramp is connected to the base of Q17. Transistor Q14 serves as a constant current source. Dual transistor Q17 (1 and 2) function as a differential amplifier, which compares the ramp voltage and the voltage across C32. If there is a difference when the sampling pulse closes the loop, a correction voltage is applied by Q13-Q15, through the transistor Q10, in such a way that the difference is cancelled.

6-79 At the termination of the sampling pulse, gate Q10 opens and capacitor C32 remains at the last sampled voltage until the next sampling pulse. Transistor Q16 is an

emitter follower. Diode VR3 shifts the dc level of the ramp and connects it to the input of complementary pair of emitter followers Q13 and Q15. It should be noted that the circuitry associated with the transistors Q13, Q14, Q15, and Q17 acts in the same manner as an integrated circuit operational amplifier, except for the higher current capabilities of the discrete component circuit.

6-80 RECORD PHASE ERROR AMPLIFIER

6-81 The record phase error amplifier circuitry is located on board 15 and consists of drum phase control potentiometer R9, operational amplifier A6, and transistors Q9 and Q11.

6-82 Operational amplifier A6 is connected as a differential comparator. One input, at A6-3, is the dc output voltage from the vertical phase comparator sample-and-hold circuit. The second input, at A6-2, is a dc adjustable voltage (R9-DRUM PHASE). Changing the dc level at which the ramp is compared causes the 1/A tach interval to vary with respect to the vertical interval of the picture. This has the effect of varying the position of the vertical sync pulse which is recorded on the tape by head #4.

6-83 Loop gain of this phase loop is very high, to provide the necessary holding characteristics after capture. Before capture, the output voltage from A6-6 consists of large voltage excursions which drive the error amplifier into a non-linear condition, preventing capture.

6-84 The large voltage excursions produced from A6-6 when the phase circuit is tending to hunt are rectified in the peak rectifier circuit, consisting of C27, C35, CR4, and CR5. The rectified voltage is connected to the base of transistor Q11. When the base of Q11 is positive, transistor Q9 conducts and increases the feedback in the operational amplifier A6, decreasing the gain and increasing the frequency response of the phase loop. Once phase lock occurs, the large

voltage excursions from A6-6 cease, Q9 stops conducting, and the phase loop gain is restored.

6-85 CAPSTAN SERVO

6-86 INTRODUCTION

6-87 The capstan servo block diagram is shown in Figure 6-7. Timing waveforms are shown in Figure 6-8. The circuits performing this function are located on the capstan assembly, the power distribution assembly, the capstan servo board J13, and on the chassis. For purposes of description, the circuits are divided into three functional groups: the capstan assembly, the frequency (speed control) circuits, and the phase control circuits.

6-88 The capstan is connected directly to the shaft of the capstan motor. This motor is a dc operated device. A tachometer disc is also attached to the shaft and is used to indicate rotational speed. During the record mode, the capstan tachometer signal is compared with a stable frequency source to produce a control signal for the capstan servo; the capstan servo then controls the capstan speed to produce a longitudinal tape speed of 15 inches per second (plus or minus standard tolerances). The source of stable frequency for the capstan servo is the drum tachometer signal, which (when the VR-3000 is in the record mode) is controlled by the vertical sync pulses from the input video. During playback, the capstan speed is controlled by comparing the phase of the head drum and the phase of the control track on tape. In this way, the tape is positioned so that any selected track may be positioned under the head traverse, which is controlled by the TRACKING CONTROL.

6-89 The work to move the tape is actually supplied by the take-up reel motor. The capstan motor is used to produce only the torque necessary to correct any variation of tension, to maintain proper tape speed. In operation, if the tape is moving at the correct speed, the capstan motor does not

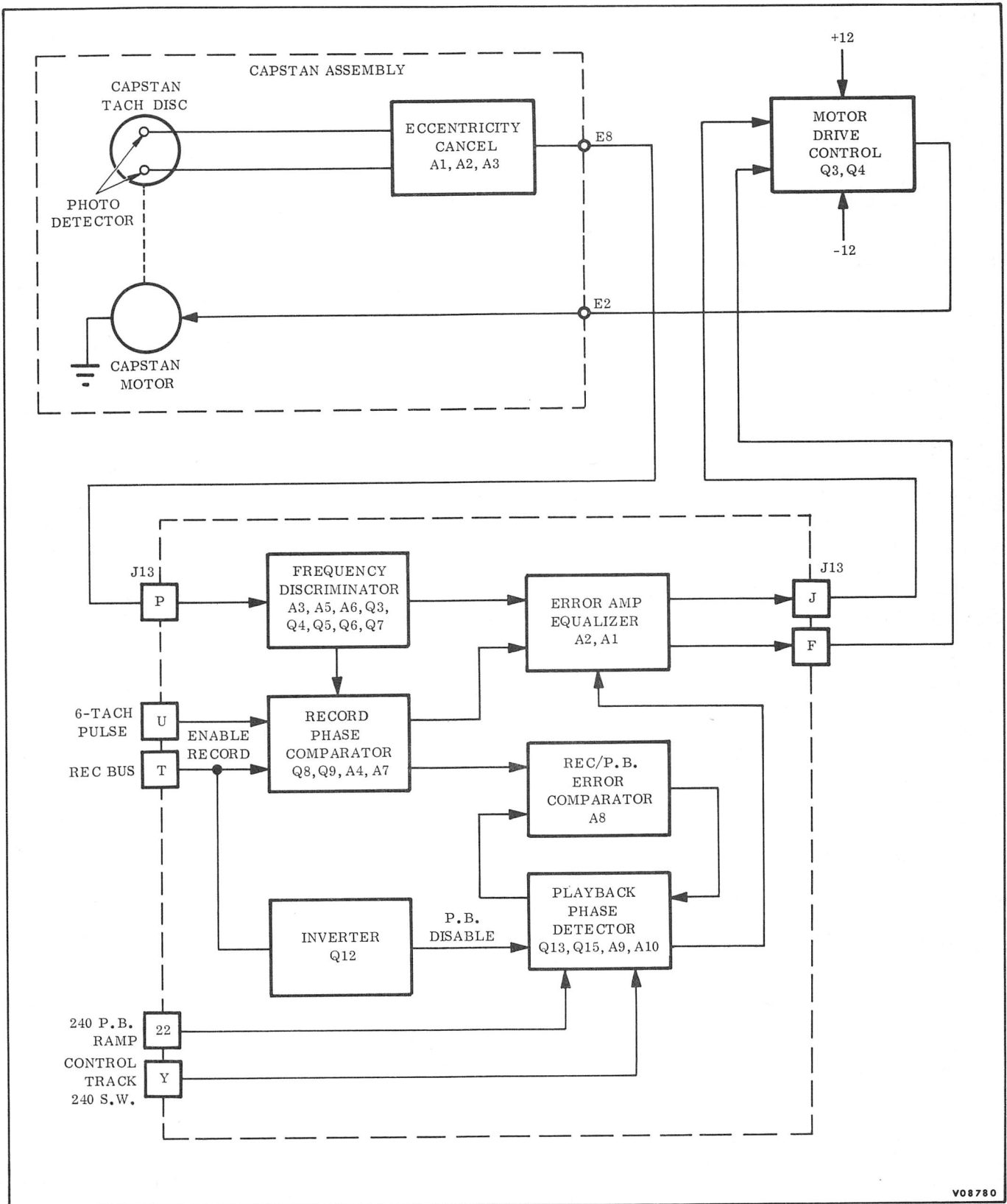


Figure 6-7. Capstan Servo Block Diagram

contribute to or remove any tension from the tape. If the tape starts to move faster, the capstan servo causes the capstan to drag against the motion and unbalance the tape tension so that the reel servos readjust the torque to rebalance tape tension. Conversely, if the tape starts to run slower, the capstan servo causes the capstan motor to introduce torque, so as to unbalance the tape tension and cause the reel servos to increase reel torque to rebalance the tape tension.

6-90 A record/playback phase comparator is included in the capstan servo to prevent large error excursions in capstan motion when switching from a pre-record play mode to a record mode. This switching is inherent in the design of the VR-3000 VTR. Because of the portable nature of the VR-3000, uneconomical use of tape is avoided. At the termination of each record or play mode, the tape is rewound automatically for a tape play time of 1 second; this is approximately 15 inches of tape. When the next record mode operation is selected, the VR-3000 switches to a control track playback mode, sensing for the presence of the control track. If the control track is present, indicating the presence of a previously recorded tape, the VR-3000 remains in this mode. When the control track is no longer detected, it is assumed that the tape is clean and no previous recording is on the succeeding portions of the tape. At this instant, when the control track is no longer sensed, the VR-3000 switches to the record mode.

6-91 During the switching time, large errors between the capstan record mode servo loop (speed signals plus a comparator signal from the drum tachometer and the capstan tachometer) and the play mode servo loop (speed signal plus a comparator signal from the control track phase and the drum phase) may exist and cause the capstan to attempt to correct this large error. The record/playback phase comparator combines the two phase error signals and develops a correction signal (identical to a fine tracking control) for the capstan servo so as to equalize the record phase comparator output with that

of the playback phase comparator before switching to record.

6-92 CAPSTAN ASSEMBLY

6-93 The capstan assembly is located on the chassis. It consists of the capstan, the dc motor, the light sources, the dual tachometer disc assembly, the eccentricity cancelling circuitry, and capstan preamplifier. The two light sources are positioned axially, 180° around the motor shaft. The photo detectors are used to pick up the transmitted light (through the tach discs); each is aligned with the associated light source.

6-94 The tachometer discs consist of two glass discs with 1024 alternating black wedges and transparent sections. One disc is attached to the motor shaft and rotates with the motor, while the other is fixed to the capstan housing. As one disc rotates with respect to the second one, the light is alternately transmitted and occluded.

6-95 Error cancelling circuitry is used to compensate for out of round or residual radial bar displacements.

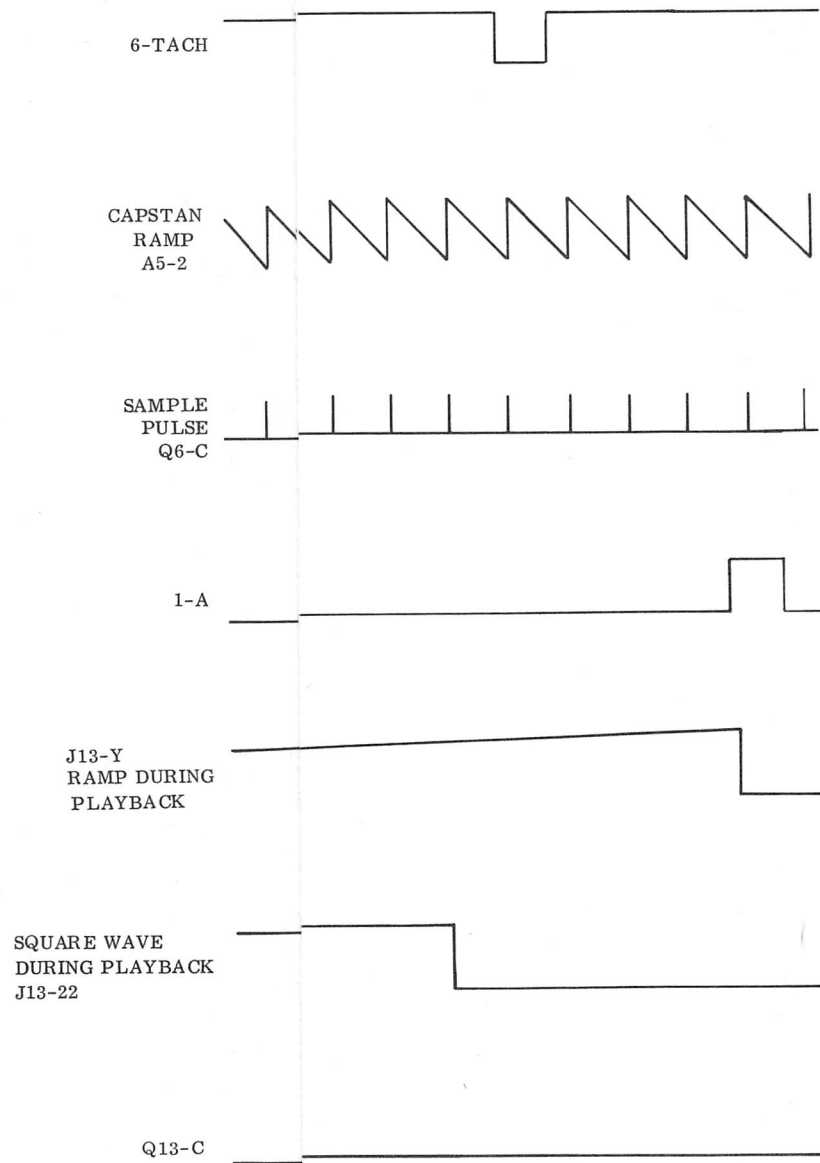
6-96 SPEED CONTROL

6-97 The speed control circuitry is located on the capstan servo board, #13, and consists of the frequency discriminator, differential comparator, error amplifier/equalizer, record phase comparator, a playback phase comparator, and the playback/record error comparator.

6-98 The frequency discriminator accepts the capstan tachometer signal and generates a signal which is proportional to the speed of the capstan. This signal is compared with a reference dc voltage by the differential comparator A2 and produces an error voltage which, after amplification, is applied to the motor to correct the speed, if required.

6-99 PHASING CONTROL

6-100 During record mode it is necessary to keep the longitudinal speed of the tape at



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Figure 6-8. Capstan Servo Timing Waveforms

15 inches per second, plus or minus standard tolerances. The speed loop brings the capstan speed to within the capture range of the phase loop, and is then used to lock the capstan rotation to an accurate frequency source. A convenient source of this accurately controlled reference signal is the drum tachometer (6-tach) signal. The drum and capstan rotations are effectively locked together at a constant speed ratio (6:1). The 6-tach pulse is used as the sample-and-hold gate for the capstan record ramp.

6-101 Because of the transverse track placement, playback capstan speed must be controlled in such a manner that the position of a recorded track always falls accurately under a video head. Absolute phasing of tape position and head drum rotation is desirable so that a head passes over the same track it recorded. In playback the control track signal is phase compared with the rotating head drum signal (1/A pulses).

6-102 The record/playback error comparator is used to adjust the phase of the capstan slightly, to compensate for any discrepancies between the record capstan error signal and the playback capstan error signals during the pre-record/playback mode. This capstan adjustment is performed to cause the two error signals to be equal (or nearly so) for a short period of time, preventing the capstan from suddenly searching for a new lock-in point upon transition from playback to record.

6-103 CAPSTAN MOTOR

6-104 The capstan motor consists of a brush-type, low-inertia, permanent-magnet, dc motor. The capstan is attached directly to the motor shaft. Shaft speed is controlled by the magnitude of the input voltage to the motor. Rotation sense is controlled by the polarity of the input voltage to the motor. The motor circuit is shown in the schematics, Figures 10-1, 10-15, and 10-26.

6-105 TACHOMETER DISCS

6-106 The tachometer discs consist of two circular transparent discs with 1,024 opaque wedges positioned radially on each disc. The area of the opaque wedges is half the area of the discs. The remaining area is transparent.

6-107 In operation, one disc is held stationary while the other is rotated with the motor shaft. As the rotating disc moves with respect to the stationary one, the light transmission characteristics change from partially transparent, when the two discs have their transparent segments lined up, to totally opaque, when the opaque segments of the two discs are staggered. When the shaft is turning at its nominal speed, the transmitted light is chopped at a rate of 8640 cycles per second (9000).

6-108 Production tolerances, during the manufacture of the tachometer discs, allow a small margin of eccentricity. The apparent result is an increase of frequency for half a rotation and a decrease of frequency for the remaining half of the rotation. Eccentricity error introduced in this way is cancelled in the capstan preamplifier circuitry as described below.

6-109 The light source, for use in the tachometer, consists of two semiconductor diode light sources located on one side of the tachometer discs and positioned 180° around the rotational axis of the motor. The chopped light sources are detected by two photo detectors, Q1 and Q2. These are located on the other side of the tachometer disc, away from the light sources.

6-110 ECCENTRICITY CANCEL AND CAPSTAN TACH PREAMPLIFIER

6-111 Eccentricity error cancellation is performed electronically by operational amplifiers A1 and A2. This circuitry is located at the capstan assembly on the capstan preamplifier board, 1361570. The circuitry is shown in schematic, Figure 10-26.

6-112 The light source consists of diodes CR1 and CR2, located on the light assembly board. As the tachometer disc rotates, energy from the two light sources is chopped and the photo detectors Q1 and Q2 change their internal resistance in response to the varying light. This is seen as a change in voltage at the output of the photo detector. This signal is coupled through capacitors C2 and C6, to the inputs of the operational amplifiers A2-6 and A3-6, respectively. The output signals at A2-6 and A3-6 are each integrated into a triangular wave and then summed in resistor R5. This operation cancels any eccentricity error. The summed triangular wavetrain is connected to the input of one operational amplifier at A1-2. The output of the capstan preamplifier at A1-6 is a symmetrical, positive square wave with a prf of 8640 Hz (9000 Hz).

6-113 FREQUENCY DISCRIMINATOR

6-114 The frequency discriminator is located on the capstan servo board #13 and shown in schematic, Figure 10-25. The circuits consist of the quad inverters A6, transistors Q3 through Q7, and operational amplifiers A3 and A5. This discriminator operates in a manner similar to the drum discriminator, which is shown in Figure 6-5.

6-115 The 8640 Hz square wave is used as input to the frequency discriminator at A6-4. The signal path is A6-8, through R47, into inverter at A6-3 and out at A6-7. Transistor Q6 is normally conducting fully. The first positive-going edge of the tachometer pulse at A6-7 causes Q6 to cut off. Capacitor C17 and resistor R36 serve as a differentiator circuit with a time constant of 2 microseconds to define the length of the negative-going pulse at Q6 collector. When this 2 microsecond pulse occurs, transistor Q3 conducts and the feedback loop from the output of operational amplifier A3-6 to the input at A3-2 is connected. Depending on the instantaneous value of the ramp voltage at A3-3, at the instant that the pulse at Q3 base is terminated, the output of the operational amplifier and the input at A3-2 will have the

same value of the voltage as the ramp. Capacitor C8 is charged to, and stores this voltage.

6-116 The delay introduced by the time delay circuits and time constants, C16-R35-A6 and C18-R38-A6, delays the capstan tachometer pulses so that the ramp is reset immediately after it is sensed by the sample-and-hold circuit A3, Q3.

6-117 The ramp is generated by allowing capacitor C10 to discharge from its reset voltage toward ground. The delayed tachometer pulse causes transistor Q7 to conduct, and this in turn causes Q5 to conduct. The voltage at the emitter of the emitter-follower Q4 is applied to capacitor C10 and to the input of operational amplifier A5-2. The reference voltage at A5-3 is balanced by the input voltage at A5-2, which is connected to the output at A5-6 (through Q4 and Q5). To bring the circuit into equilibrium, the voltage at the output A5-6 compensates for the reference voltage by bringing the input A5-2 to the same voltage as the reference. At the termination of the delayed tachometer pulse, the path is opened and capacitor C10 begins to discharge toward ground potential, through resistor R32.

6-118 The sample-and-hold for the discriminator consists of operational amplifier A3 and gate Q3, Q6. Each capstan tachometer pulse causes a sampling of the ramp voltage immediately before the ramp is reset. This voltage sample is held as a charge in capacitor C8. The sample-and-hold voltage is used as an input to the differential comparator A2.

6-119 CAPSTAN SECOND ORDER SPEED CONTROL

6-120 The capstan second order speed control circuits are located on the capstan servo board #13 and consist of the operational amplifiers A4 and A7 through A10, together with transistors Q8, Q9, Q13, and Q15. In record mode, the frequency discriminator generates the first order speed error signals,

which bring the capstan speed to within range. The second order speed control circuits, which consist of the record phase comparator A4, A7, Q8, Q9, are also used during record to hold the capstan speed at an exact rate, so that the capstan tachometer is generating a signal at a frequency of one-sixth the frequency of the 6-tach pulses.

6-121 During playback, the playback phase detector, consisting of A9, A10, Q13, Q15, compares the phase of the control track signal and the phase of the head drum to generate the error signal which is used to hold the capstan speed exactly at the rate which will allow each transverse scan of a head to pass directly over the track which it recorded. Any head may be made to pass over any selected track by varying the phase of one of the input signals to the playback phase detector.

6-122 RECORD PHASE COMPARATOR

6-123 The ramp voltage from the capstan discriminator circuit is used as one input to the sample-and-hold circuit, at A4-3. Refer to Figure 6-9 for the functional block diagram. The positive-going edge of the 6-tach pulse input at J13-U produces a positive pulse at the base of Q9, which causes Q9 to cut off. Transistor Q9 collector goes negative and transistor Q8 conducts, closing the sample-and-hold feedback loop from A4-6, through Q8, to A4-2. The voltage at A4-6 is coupled to the input at A4-2 and causes a voltage change so as to balance the voltage at A4-3, at which time equilibrium is reached and the voltage at A4-2 is equal to the voltage at A4-3. When the input at the base of Q8 returns to a positive potential, Q8 cuts off and the voltage across C20 is held, by virtue of the fact that C20 has no discharge path. This voltage represents the phase of one of 36 points in the rotation of the capstan, with respect to the trailing edge of the 6-tach pulse.

6-124 The operational amplifier A7 uses this voltage as one of its inputs while using a reference voltage, which is determined by the voltage divider R53, R55, and the +12

volt power input, as the other input to produce a capstan velocity error signal at A7-6.

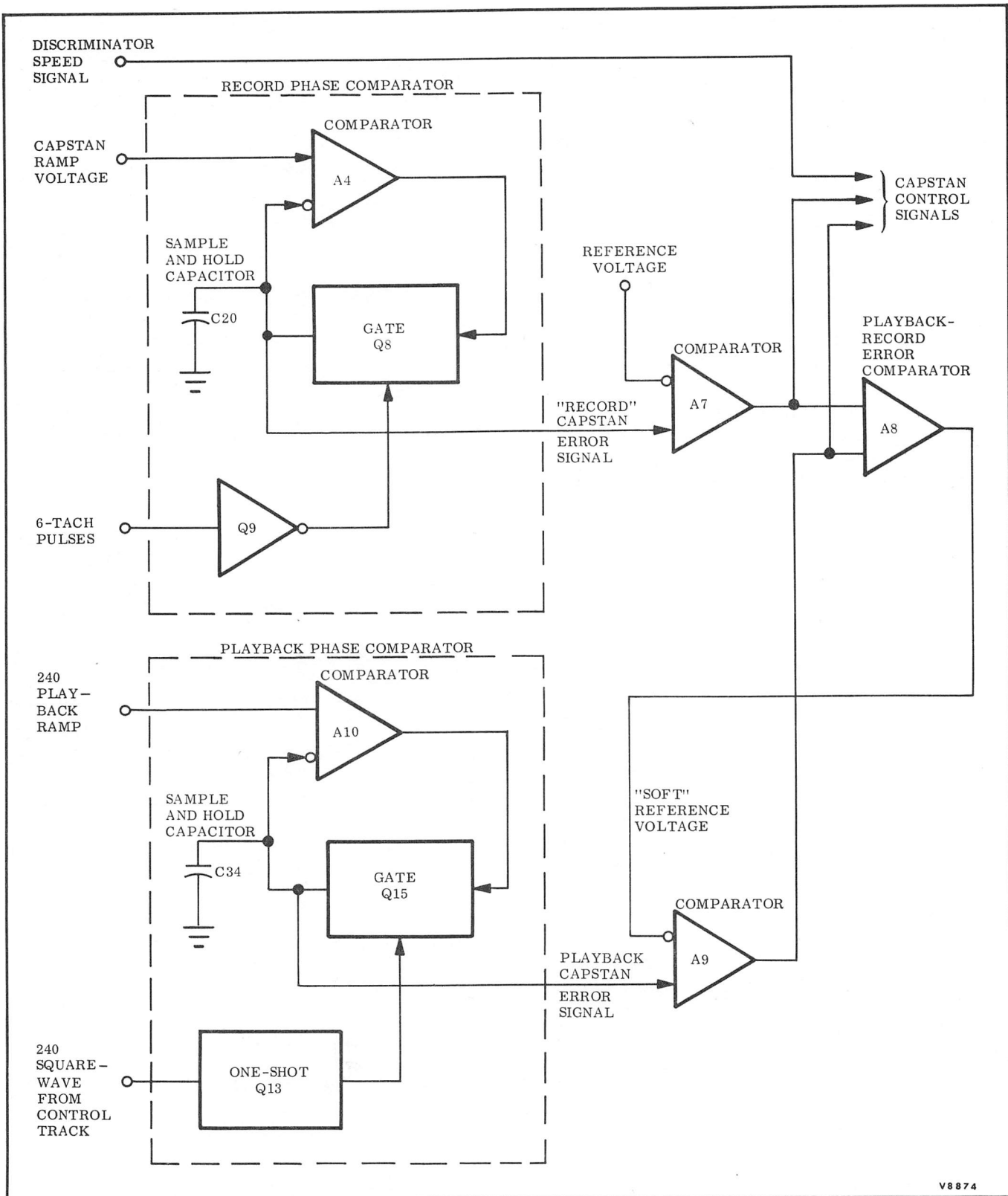
6-125 Transistors A10 and Q11 are used to disable the record phase comparator circuit when the VR-3000 is not in the record mode. This is accomplished by placing a positive voltage on the base of transistor Q11 during record mode, which allows the base of Q10 to be at ground potential and Q10 to be cut off, allowing the output at A7-6 to be used. When the base of Q10 is at ground its collector is at a positive potential; Q10 is cut off. Q11 is saturated, shorting the output of A7-6 to ground.

6-126 PLAYBACK PHASE DETECTOR

6-127 The playback phase detector circuits are located on the capstan servo board #13. This is shown in schematic, Figure 10-25, and functional block diagram, Figure 6-9. The circuitry consists of operational amplifiers A9, A10, and transistors Q13, Q15.

6-128 Operational amplifier A10 and transistor Q15 serve as a sample-and-hold circuit, using the ramp voltage which is generated from the 1/A pulse in the control track circuit, and a square wave which is generated as a result of the playback of the previously recorded control track. The square wave enters at J13-22 and is connected to the base of Q13. The ramp voltage enters at J13-Y. The TRACKING CONTROL R5, on the chassis, allows the square wave to be moved in time, with respect to the actual control track. The output at A10-2 is a dc voltage which is representative of the position of the control track with respect to the phase of the drum. This voltage is applied to A9-3. The second input to A9-2 is a reference voltage which is determined by the voltage divider R58, R59, and the +12 volt power. The output at A9-6 is an error signal used as a velocity error to adjust the position of the tape by slowing down or speeding up the longitudinal velocity of the tape.

6-129 Transistor Q12 is connected so that it conducts when the record bus is positive.



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Figure 6-9. Capstan Speed Control Block Diagram

This causes the playback phase error signal to be shorted to ground. When the record bus is at ground potential, the output at Q12 collector is not shorted to ground.

6-130 PLAYBACK/RECORD ERROR COMPARATOR

6-131 When the VR-3000 is stopped, following a record or playback mode, the tape automatically rewinds about 15 inches of tape. If a record mode is then selected, the VR-3000 begins to operate, with the drum being synchronized to the input video, vertical sync pulses and the capstan being synchronized to the control track and the head drum. This pre-record play mode is maintained until the control track is no longer sensed, then the VR-3000 automatically switches to record.

6-132 Capstan control in record mode depends on the signals from the 6-tach, which is developed as a result of drum rotation. Refer to Figure 6-8. In playback, capstan control is developed from the previously recorded control track and the capstan tachometer signal. During the pre-record/play mode, signals for control of capstan motion are a combination of both the record and play mode control signals. The record capstan error signal and the play capstan error signal are subtracted algebraically in the operational amplifier A8 and the output used to alter slightly the operating point of the playback error signal from A9-6.

6-133 In this way, the capstan error, at the instant when the VR-3000 switches from playback to record, is reduced to a minimal value and no large switching transients occur. The phase of the newly recorded control track is aligned with the previously recorded control track to appear as a continuous control track.

6-134 CONTROL TRACK CIRCUITRY

6-135 INTRODUCTION

6-136 The control track block diagram is shown in Figure 6-10. The circuits per-

forming this function are located on the control track board J14. The circuitry can be considered as two functional groups, record and playback, of the control track. The record circuitry consists of the control track ramp generator, the one shot delay, control track record amplifier and filter, servo lock detector, and frame pulse generator. The playback circuits consist of the control track playback amplifiers and filter, and the control track detector.

6-137 During recording, the 1/A signal from the drum servo, which indicates the position of the drum, is used to generate a 240 Hz control track signal. The phase of the control track signal has a direct relationship to the phase of the drum which was recording video at the time the control track was recorded. The frame pulse is recorded on the control track in addition to the 240 Hz (250 Hz) signal, and consists of a 30 Hz (25 or 12.5 Hz) pulse which is coincident with alternate vertical sync pulses from the input video signal, and is located on the control track according to the video standard used.

6-138 When the control track is sensed during playback, a control track detector generates a positive voltage, for use in other parts of the VR-3000. The control track head is used for both recording and playback. During playback, the signal is amplified and filtered. The output from the playback amplifiers and filters is a 240 Hz square wave signal.

6-139 RECORD CIRCUITRY

6-140 All circuitry for generation of the control track and the frame pulses is located on the control track board #14. The circuit is shown in the schematic, Figure 10-23.

6-141 The 1/A pulse, from the once-around pulse generator on board #16, is connected to the base of transistor Q1. This pulse goes positive for approximately 140 microseconds and causes the transistor Q1 to conduct heavily and discharge capacitor C15, through resistor R5. At the trailing edge of the 1/A

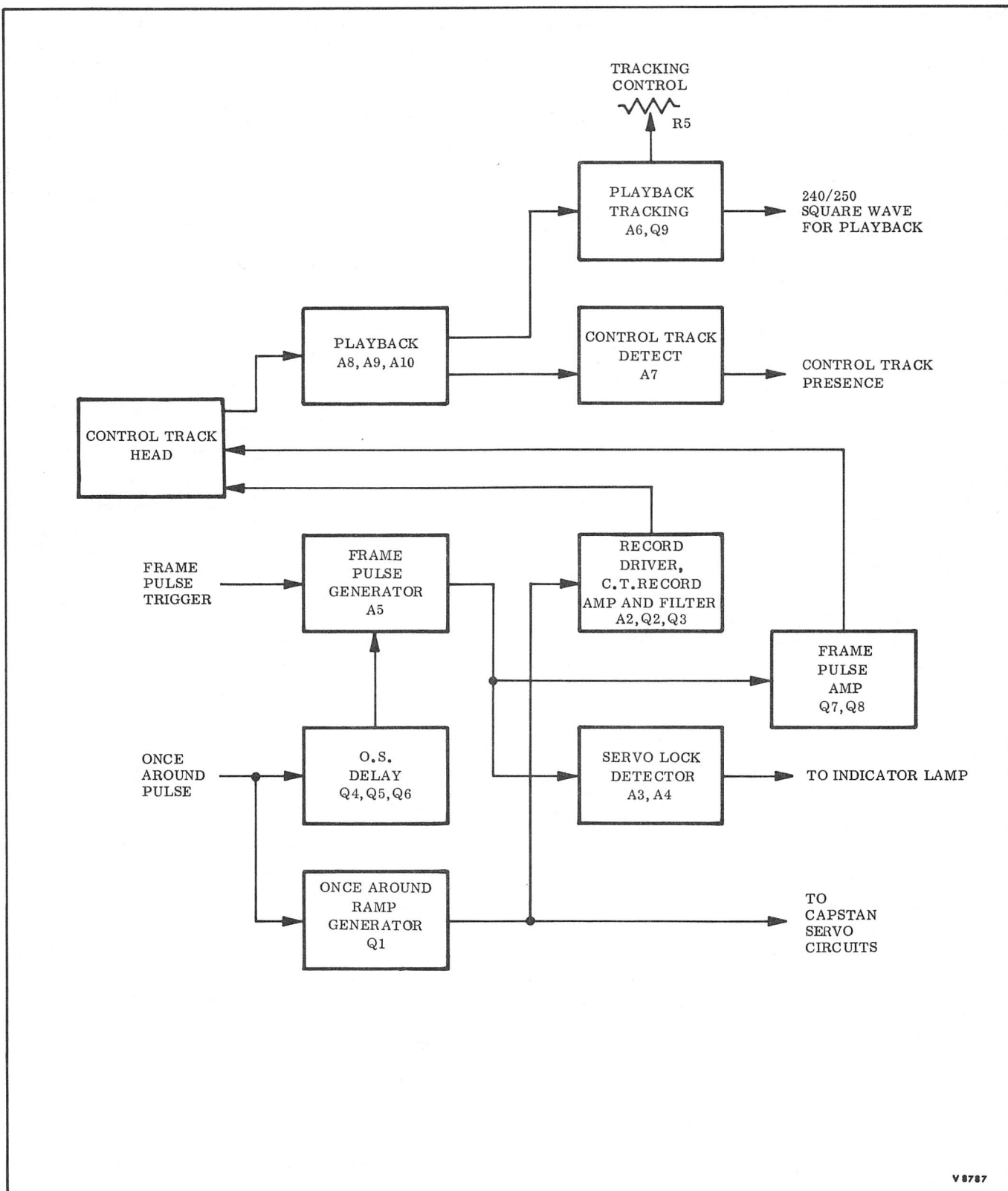


Figure 6-10. Control Track Block Diagram

pulse, the discharge path through transistor Q1 is removed and capacitor C15 begins to charge toward +12 volts, through R4. The charging of C15 continues until the voltage reaches approximately 4 volts, when CR1 conducts. Operational amplifier A1 uses this ramp signal as the input to A1-2 and an adjustable dc voltage (R1) as the input to A1-3. When the ramp voltage reaches the adjustable voltage, the output signal at A1-6 swings from positive to negative. The pulse width of the negative-going portion of the output signal from the operational amplifier A1 is adjusted by varying the voltage at R1. Capacitor C5 and resistor R13 are a time constant for a boxcar one-shot, producing a pulse width of approximately 2 milliseconds at Q3 collector. The output at Q3 collector is a negative-going pulse. Resistor R16 and capacitor C6 comprise a pre-filtering network. Resistor R2 is used to adjust the recording level.

6-142 The recording amplifier for the control track signal consists of operational amplifier A2, while the filter consists of inductor L1 and capacitors C2 and C7, located in the feedback path. The output of this amplifier is connected to the control track head through coupling capacitor C18 and resistor R15.

6-143 FRAME PULSE GENERATOR AND SERVO LOCK DETECTOR

6-144 The circuitry is located on the control track board #14. These functions share the common one-shot delay consisting of Q4, Q5, and Q6. The negative-going trailing edge of the 1/A pulse at the junction of C8 and terminal J14-B is differentiated in the RC circuit consisting of C8-R17 to produce a negative-going transient pulse to the input of the inverter A4-3. The output at A4-7 is normally at ground potential, because of the quiescent state current through R17. The output at A4-7 goes to a positive potential and transistor Q5 conducts. This causes the collector of Q5 to go to a near ground potential. The negative-going transient is coupled through capacitor C9 to the one-shot Q4. Capacitor C9 and resistors R22 and R3 are the

time constant for the one-shot. Transistor Q4 cuts off for the period of its cycle and its collector goes toward the positive supply voltage for an adjustable (R3) period of from 300 to 350 microseconds. When the positive-going, leading edge occurs, it is coupled through the combination of R26, C12 to the base of Q6. Transistor Q6 conducts and provides a short circuit to ground to hold the one-shot for its period. Even though the input pulse has been terminated, the circuit remains active because of this holding path, through Q6. Capacitor C9, in the circuit consisting of C9, R3, and R22, discharges sufficiently at the end of the period to allow the base voltage of Q4 to rise so that Q4 comes out of cut-off. The voltage at the collector of Q4 drops toward ground potential. This pulse is connected to the input of the inverter at A4-2 and to the input of the flip-flop A3 at the clear terminal, A3-3. The output of the inverter A4-8 is connected to the set input terminal of A3, at A3-1. The frame pulse trigger is connected to J14-J and to the input of inverter A4 at A4-1. This inverted trigger pulse at A4-9 is used as the clock for the flip-flop. If the trigger pulse arrives in time for the negative-going pulse at Q4 collector, the flip-flop changes state to indicate the coincidence of the pulses. This condition indicates a successful servo lock. The output of the flip-flop at A3-7 is connected to the terminal J14-3 and is used as the servo lock indication.

6-145 The NOR gate outputs A5-6 and A5-6 are connected as a one-shot timing circuit, producing a pulse with the length of a frame pulse. The input at A5-5 is the disable input, preventing generation of the frame pulses when the record servo lock signal is not present. Transistors Q7 and Q8 switch the -12 volt supply voltage to the board, through resistor R36, for the length of the frame pulse.

6-146 PLAYBACK CIRCUITRY

6-147 The control track playback circuitry consists of the operational amplifiers A6, A8, A9, and A10 and transistor Q9. The

control track signal from the control track head is applied to the operational amplifier A9-2. The output at A9-6 is connected to the input of the amplifier-filter at A10-3. The output at A10-6 is a sine wave of 240 Hz. Operational amplifier A8 squares the sine wave into a symmetrical square wave. Capacitor C25 and resistors R47 and R48 serve as a differentiator circuit, to produce the positive-going transient pulse, at the positive-going edge of the square wave, to cause transistor Q9 to conduct heavily and discharge the capacitor C27. When the tran-

sient pulse is terminated, capacitor C27 begins to charge through resistor R45. This produces a ramp voltage which is used as one input to the operational amplifier A6. The second input to this amplifier is the tracking control voltage adjustment signal from the manual TRACKING control. This control sets the cross-over point in the amplifier so that the output is a negative-going square wave signal with an adjustable pulse width. This square wave is used in the playback phase comparator, located on the capstan

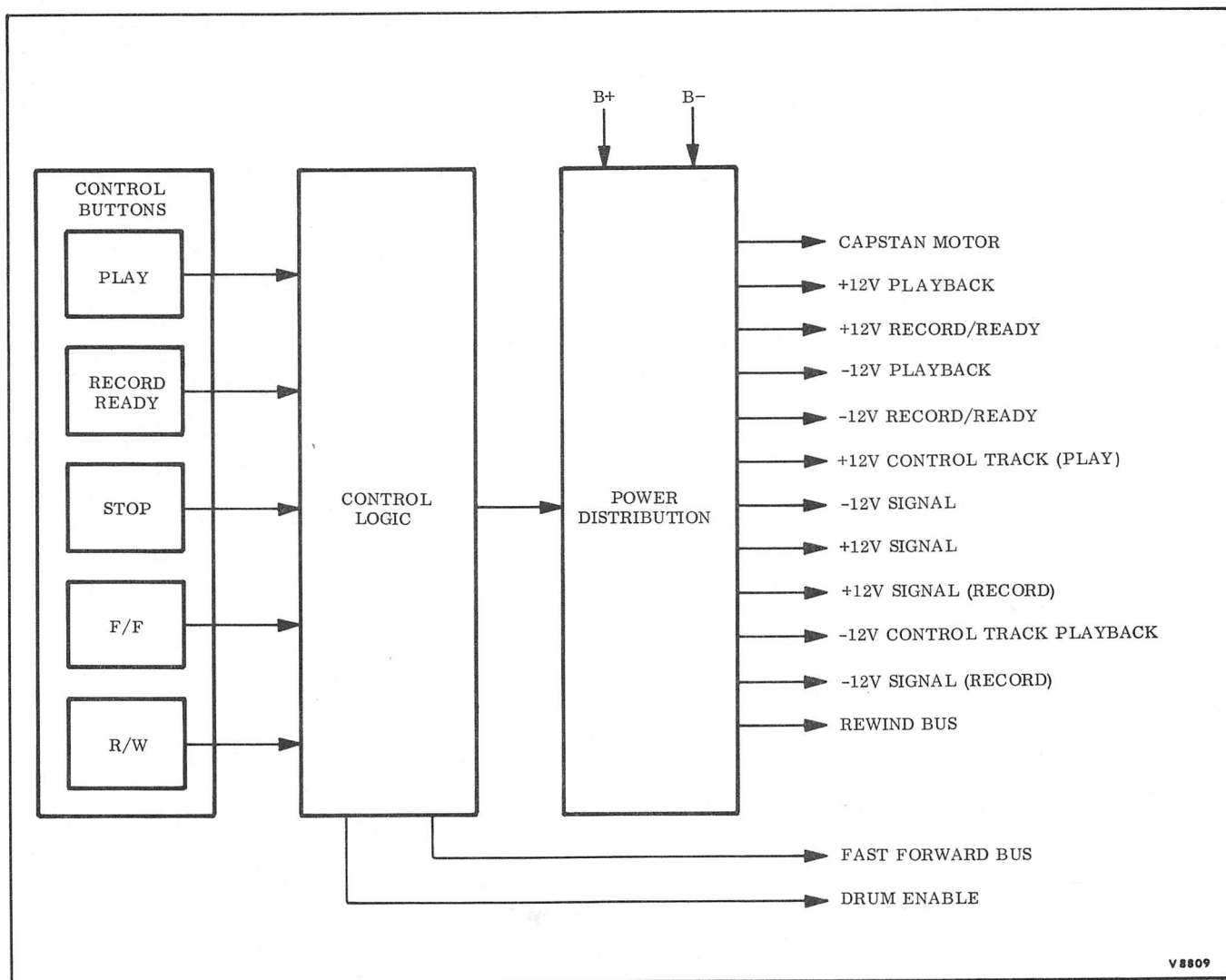


Figure 6-11. Control Logic Block Diagram

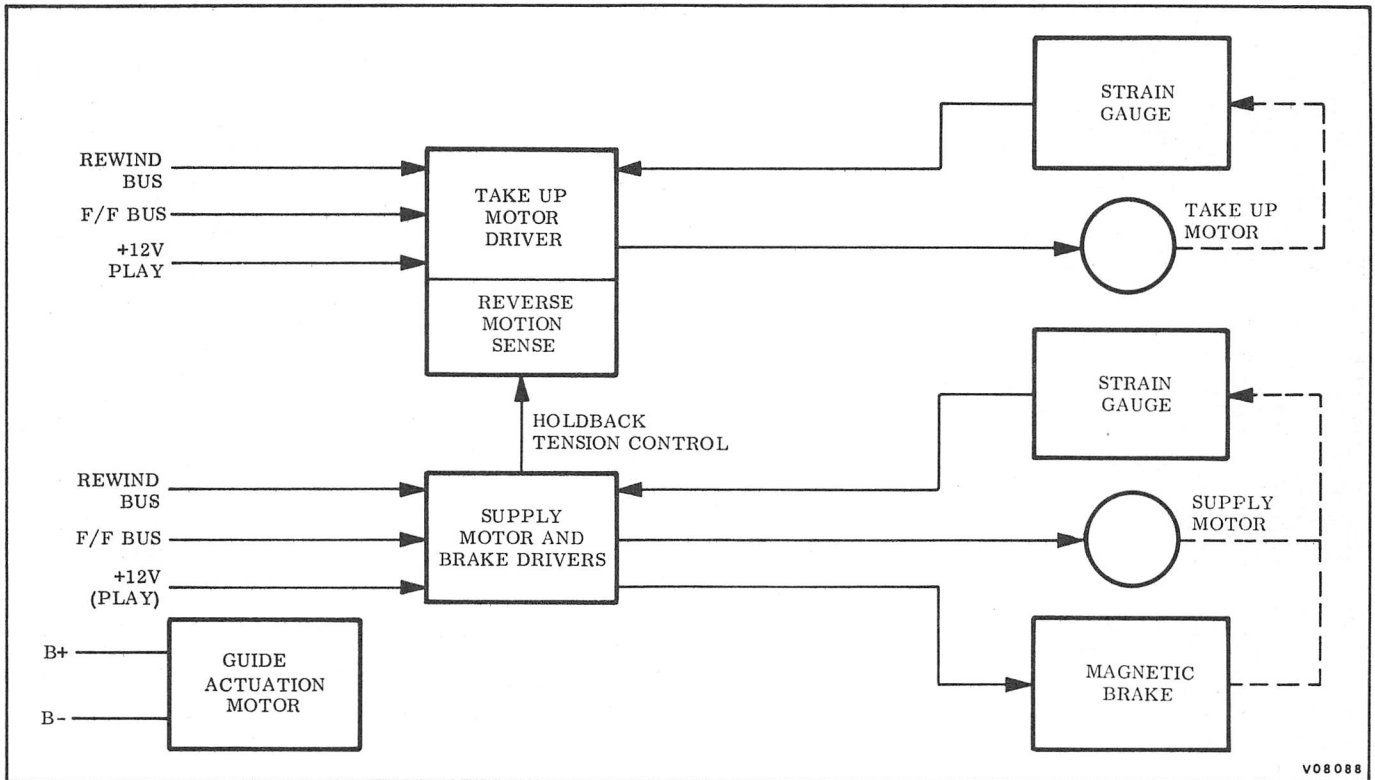


Figure 6-12. Reel Servo and Guide Actuation Motor Block Diagram

servo board. The TRACKING control R5 allows selection of any of the 4 tracks.

6-148 CONTROL TRACK DETECTOR

6-149 The control track detector circuitry consists of operational amplifier A7 and peak rectifier circuit CR4, CR5, C21, and C22. A takeoff point is provided for the control track signal at A10-3. This signal is amplified in the operational amplifier A7 and peak rectified. The output at terminal J14-V is a dc voltage which is present when the control track is present and a voltage of ground potential, when the control track is absent.

6-150 CONTROL CIRCUITS

6-151 INTRODUCTION

6-152 The control circuits are shown in the block diagram, Figures 6-11 and 6-12. The control circuits provide signals which result from operation of the control buttons on the transport of the VR-3000 VTR. In addition,

the control circuits operate the +3.6 volt regulator, ± 12 volt regulators, takeup motor and supply motor operating voltages, the guide actuation motor, and vacuum pump motor.

6-153 The circuits which perform the above functions are located on the control logic board #12, the takeup motor drive board #2, the supply motor and brake driver board #1, the takeup reel tension adjust board #9, and the guide actuation motor assembly #6.

6-154 CONTROL LOGIC

6-155 The control logic circuits are shown in Figure 10-14 and generate the control signals for the following operations: stop, play, record/ready, record, fast forward, and rewind. Each of these operating modes consists of a series of separate but coordinated operations. Each operating mode is initiated by pressing at least one of the control buttons on the VR-3000 VTR chassis. When a camera such as a BC-300 is used in

conjunction with the VR-3000 VTR, pressing one of the control buttons on the camera initiates the operating mode. All controls are interlocked against the simultaneous engagement of conflicting functions.

6-156 PARKING BRAKE ASSEMBLY

6-157 The parking brake assembly consists of board #8 and is shown in Figure 10-13. The assembly consists of switch S1, diode CR1, and resistor R1. When the parking brake is extended out against the reel rims, switch S1 closes and provides a positive voltage for the stop bus, simulating operation of the STOP switch.

6-158 VACUUM PUMP

6-159 The vacuum pump is a low volume, dc operated pump which provides the necessary tape guide vacuum. This pump is capable of the required operating vacuum, but its volumetric capacity is insufficient, when first starting, to attract the tape into the vacuum tape guide. When first starting the drum, the guide is programmed to approach the tape, which seals against the guide, then retracts the tape from the head drum if contact is not required.

6-160 TAKEUP MOTOR DRIVER

6-161 The takeup motor driver is shown in Figure 10-19 and consists of assembly, board #2. It provides the controlled operating voltage for the takeup motor. During stop mode, the motor torque holds the tape taut, without advancing it; during the play mode or record mode, the tape is driven forward by the takeup motor; during the fast forward mode, the full torque of the motor is needed to advance the tape at maximum speed; and finally, during rewind mode the takeup motor is called on to provide hold-back torque.

6-162 Input signals for the takeup motor driver consist of the rewind bus signal, the fast forward bus signal, the +12 volt PLAY operating voltage, and the signals from the takeup reel tension arm assembly. De-

pending on the selected mode, the output voltage to the motor is varied to produce the required torque for the application.

6-163 SUPPLY MOTOR DRIVER AND BRAKE DRIVER

6-164 The supply motor driver circuits are shown in Figure 10-18 and are housed on board #1. These circuits control the drag of the magnetic particle brake during record or play modes. During stop mode, the drag is at a maximum to prevent rotation. During rewind mode, the brake is turned off and the supply reel motor is driven to move the tape backward at a high rate. A feedback loop is included between the takeup circuits and the supply circuits to allow the rewind motor (supply reel motor) to start rewinding with near zero hold-back torque from the takeup reel motor, and to allow an increase of holdback torque as the rewind cycle comes up to speed. This feedback is also necessary as the diameter of the tape on the reels changes.

6-165 TAPE TENSION

6-166 Two identical tape tension adjust assemblies are used in the VR-3000 VTR, one for the supply reel braking circuitry and one for the takeup reel torque control circuitry. Both assemblies operate in an identical manner. Tape tension is determined by routing the tape over the respective tape tension arm and deflecting the arm in proportion to the tension.

6-167 Deflection of each compliance arm is determined by attaching a strain gauge to the arm and measuring the resistance of the strain gauge. Resistance is determined by including each gauge in a bridge circuit.

6-168 GUIDE ACTUATING MOTOR ASSEMBLY

6-169 The guide actuating motor, shown in Figure 10-20, operates a cam to retract the tape guide from the head tips. The motor and cam rotate in one direction only so that for each 180° of cam rotation, the tape guide

is alternately advanced and withdrawn. Limit switches are included to stop the cam at either the high point (180°) or low point (360°).

6-170 In operation, the control logic generates a signal to advance the vacuum tape guide against the head drum to force the tape into the female guide any time drum rotation is required. Scratching of the tape by the heads is thus prevented. For a fast forward or rewind mode, the guide is advanced so that the tape is forced into the female guide to within holding range of the vacuum, then the guide is withdrawn while still holding the tape. For a play or record mode operation, the guide is advanced and held until the mode is completed, then the guide is withdrawn.

6-171 CONTROL LOGIC

6-172 The control logic circuitry accepts the signals from the control buttons and gen-

erates coordinated control signals for the physical operations in the VR-3000 VTR. Simultaneous control is possible from the local buttons on the chassis of the VR-3000 and a remote location, such as on the BC-300 camera. The physical operations are classified into operating modes; each operating mode is a series of functions which the VTR performs to play, record, fast forward tape drive, rewind tape, maintain a ready state, and stop all operations.

6-173 The circuitry is shown in block diagrams accompanying the text and in the schematic, control logic, Figure 10-14. The following discussion is in terms of the operating modes and the associated logic circuitry functions.

6-174 PLAY MODE

6-175 The play mode is initiated by pressing the PLAY button. Refer to Figures 6-13

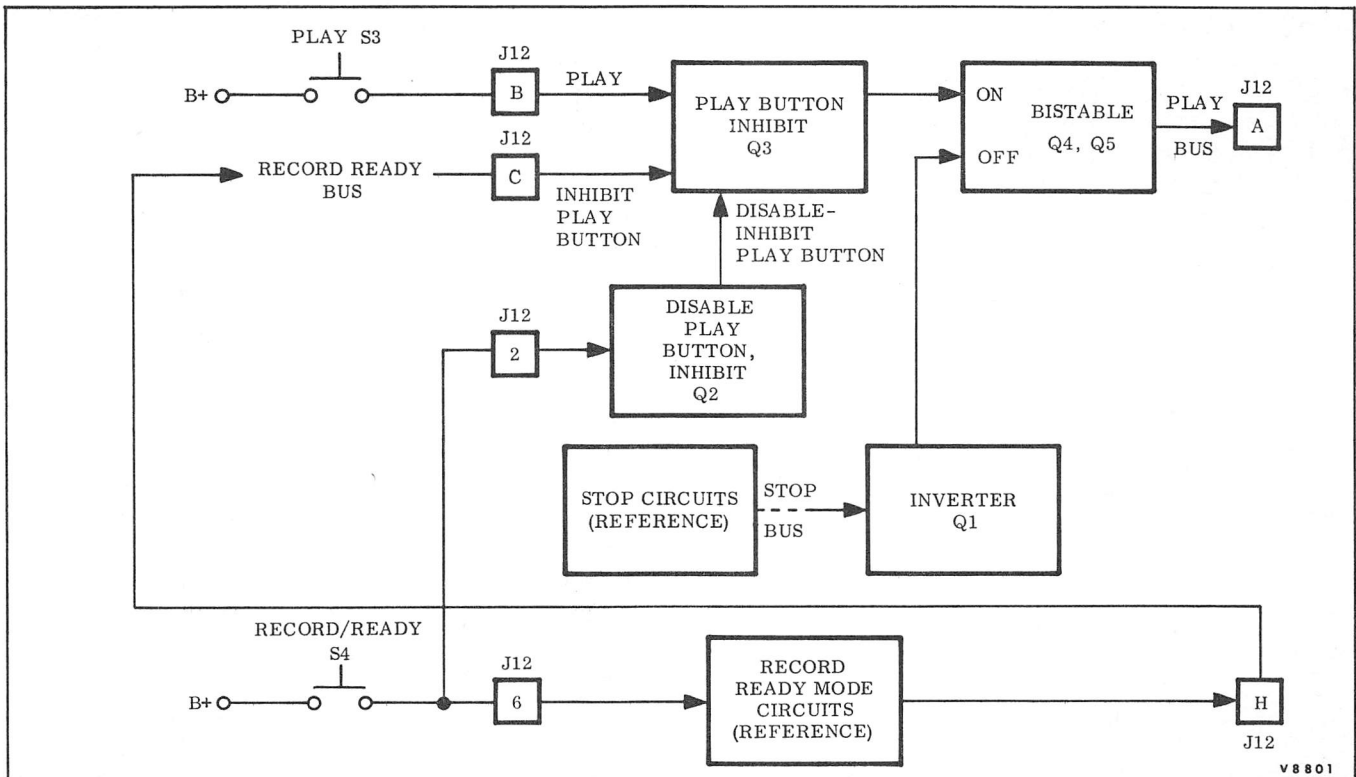


Figure 6-13. Play-Diode Control Logic Circuitry, Simplified Schematic

and 10-14. This closes the circuit through the PLAY switch S3 and provides B+ voltage to the terminal J12-B paralleled with J12-8. When the record/ready bus is active, initiation of the play mode is inhibited by the short to ground of the PLAY switch voltage by transistor Q3.

6-176 Assuming that the record/ready bus is not active, the voltage from the PLAY switch causes both transistors Q4 and Q5 to conduct. Transistors Q4 and Q5 serve as a bistable pair, with the feature that for each of the stable states, both of the transistors conduct or both of the transistors are cut off. Output is taken from the collector of Q5 and is referred to as the play bus. Feedback for the bistable, from the collector of Q5 to the base of Q4, is through diode CR1.

6-177 When the record mode is selected, it must be initiated by pressing the PLAY and the RECORD/READY buttons simultaneously. But, as mentioned in the paragraph above, the play mode cannot be initiated when the record/ready bus is active. To be able to press both buttons simultaneously and have a reaction, transistor Q2 disables the inhibit circuit consisting of Q3 when the RECORD/READY button is pressed and held down. This allows the play mode and the record/ready modes to be simultaneously active.

6-178 When the STOP button is pressed, the stop circuits provide a positive voltage to the play mode circuit at Q1 base. This voltage causes Q1 to conduct and bring its collector to 0 volts. The output at Q1 collector is used as the reset signal for the bistable circuit consisting of Q4 and Q5.

6-179 RECORD/READY MODE

6-180 The record/ready mode is initiated by pressing the RECORD/READY button. Refer to Figure 6-14. This closes the circuit through the RECORD/READY switch S4 and provides B+ voltage to terminal J12-6 paralleled with J12-2. Initiation of the record/ready mode may be inhibited by transistor Q9. When the play bus is inactive,

Q9 conducts and shunts the RECORD/READY switch S4 voltage to ground.

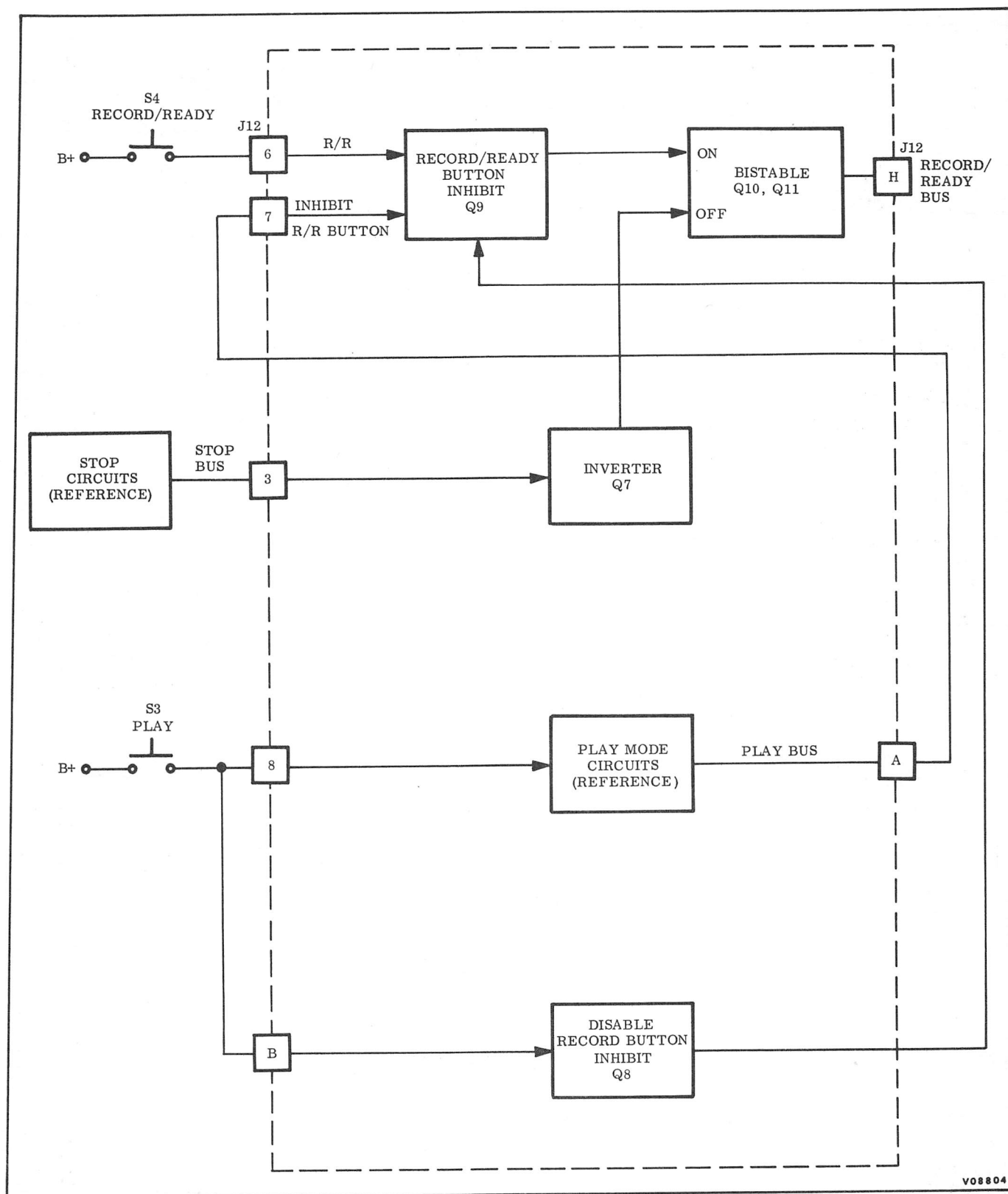
6-181 Assuming that the play bus is not active, the voltage from the RECORD/READY switch causes transistors Q10 and Q11 to conduct. Transistors Q10 and Q11 serve as a bistable pair, with the feature that for each of the stable states, both of the transistors conduct or both are cut off. Output is taken from the collector of Q11 and is referred to as the record/ready bus. Feedback for the bistable from Q1 collector to the Q10 base is through diodes CR11 and CR12, and resistor R24.

6-182 To initiate the record mode, as in the discussion above concerning play mode, it is necessary to press both of the buttons simultaneously. Transistor Q1 is used to disable the inhibiting transistor Q9, by conducting when the PLAY button is pressed and held. Thus, the play and record/ready circuits are mutually inhibiting when the associated button is pressed and released. Only when both are pressed simultaneously can the inhibiting circuits be overridden and the record mode initiated.

6-183 When the STOP button is pressed, a positive voltage is connected to the base of Q7; this saturates Q7 and shunts the input of the bistable at Q10 base to ground, causing both Q10 and Q11 to switch to the off state.

6-184 STOP MODE

6-185 The stop mode is initiated by pressing the STOP button. Switch S5 is operated and a positive voltage is applied to terminals J12-3, J12-16, and J12-11. Refer to Figure 6-15 for a simplified schematic of the stop circuits. The parking brake switch S1 operates when the reel parking brake is applied. To prevent any powered tape transport motion when the reels are clamped, S1 on the parking brake assembly is equivalent to operating the STOP switch and holding it down. This simulates a stop mode and prevents the VTR from being operated while the reels are held immobile.



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Figure 6-14. Record Ready Diode Control Logic Circuitry, Simplified Schematic

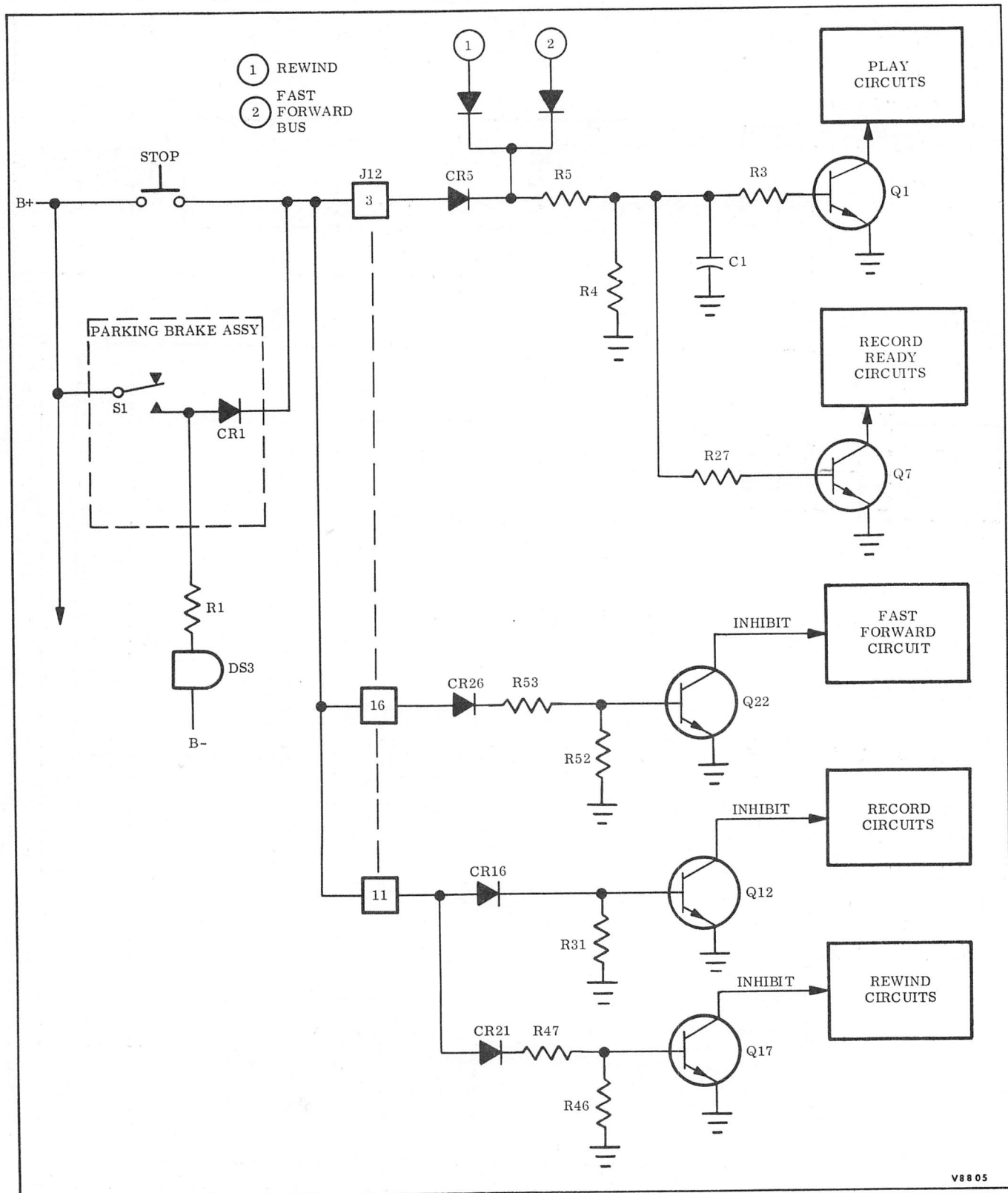


Figure 6-15. Stop Mode Control Logic Circuitry, Simplified Schematic

6-186 The positive voltage from the STOP switch is applied to the base of transistors Q1, Q7, Q12, Q17, and Q22. These transistors conduct and shunt the respective control circuit to ground potential, thus disabling the circuit in question. Transistor Q1 resets the bistable of the play mode circuitry; transistor Q7 resets the bistable in the record/ready circuitry; transistor Q22 disables the FAST FORWARD button; transistor Q12 shunts the regulator bus to ground, causing the record relay K1 in the power distribution board #20 to release; and transistor Q17 causes the rewind circuitry to reset. Operation of these transistors with respect to the operation of the respective circuits to which each is assigned is discussed in the appropriate paragraphs.

6-187 REWIND MODE

6-188 The rewind mode is initiated by pressing the REWIND button on the chassis. The B+ voltage is connected through S6 to the connector pin J12-20. Diode CR29 is forward biased, allowing current to flow to the base of Q22, which then saturates. Transistor Q22 collector provides a low-impedance path to ground for the input line to the fast forward circuitry, thereby disabling it.

6-189 The positive voltage at J12-20 is connected through the resistor R49 to the base of Q18. Only when the inhibit transistor Q17 is cut off (when the STOP button is released, the FAST FORWARD button is released, and the selected mode is play) can Q18 conduct. When Q18 does conduct, its collector goes to ground (0 volts), causing Q21 to also conduct. At the same time, Q19 becomes cut off. As long as Q21 conducts, its collector remains at the B+ voltage. The collector of Q21 is connected to terminal J12-T, which is the rewind bus.

6-190 As the tape starts to move in the rewind direction, a voltage is generated by the take-up motor reverse motion sense circuitry at J12-U. This voltage is connected to the rewind input through CR25, R51, and CR24. This reverse motion sense voltage is used to hold the rewind bus at a positive

potential as long as the take-up reel is being driven backwards. When the tape is completely run off the take-up reel, no force remains to drive the reel backwards, and the reel slows, then reverses; voltage generation ceases. The rewind mode is then automatically terminated by the absence of the reverse motion sense voltage.

6-191 Pressing the FAST FORWARD button or the STOP button causes the transistor Q17 to conduct and release the rewind circuit. The transistor Q21 ceases to conduct while Q19 conducts. The function of Q19 is to prevent the rewind mode from being inadvertently triggered by manually rotating the take-up reel in a reverse direction. Capacitor C7 prevents the rewind mode from being reinitiated immediately after the STOP button or FAST FORWARD button is pressed, if these buttons are pressed and quickly released and then the REWIND button is immediately pressed. When Q17 conducts, C7 discharges quickly, through the collector of Q17. The low impedance path to ground for the base circuit of Q18 is maintained through the discharged condition of C17; this condition is temporary until the reels stop and the reverse motion sense voltage is no longer generated.

6-192 REWIND BACKUP

6-193 At the termination of the play mode, the tape rewinds automatically, backing up approximately one second of playing time (15 inches of tape) on the supply reel. This action is incorporated into the operation of the VR-3000 VTR to give it a one-second period to synchronize with the previously recorded control track before starting a new recording operation. Consequently, the control tracks from any series of recordings on the tape are continuous in phase advance, but have a small gap between consecutive recordings.

6-194 When the play mode is terminated, the voltage at the collector of Q5 goes to ground. This negative-going voltage excursion is coupled through the time constant of R15, R16, C2, where it becomes a

negative-going voltage transient. This negative voltage at the base of Q6 causes Q6 to momentarily cut off and Q20 to saturate. The collector of Q20 goes to ground and provides a current path for transistor Q21, which conducts and raises the rewind bus voltage in the positive direction.

6-195 RECORD MODE

6-196 The record mode is initiated by pressing the PLAY and RECORD/READY buttons simultaneously. The record/ready bus and the play bus become positive. This condition is detected by the AND gate composed of diodes CR15 and CR23. A one-half second delay is introduced by R35, R36, R37, and C6 when the play mode is initially introduced. This delay inhibits the record mode. At the end of this delay, if the control track sensor voltage at pin J12-9 is positive, indicating the presence of a previously recorded control track, recording is further inhibited until the voltage at J12-9 goes to zero.

6-197 Transistor Q13 starts conducting when the record mode is initiated. This causes Q14 to conduct and provide positive battery to terminal J12-K, which is the record bus. Once Q13 conducts, the 0 volt level at the collector of Q13 clamps the control track sense input through CR18 and prevents any spurious signals from inhibiting the record mode. Transistor Q12 serves as the inhibit for the record mode circuits. The record mode is maintained by the presence of both the play bus voltage and the record/ready voltage. Both of these voltages are held by the holding circuits associated with the individual circuits.

6-198 FAST FORWARD MODE

6-199 The fast forward mode is initiated by pressing the FAST FORWARD button on the chassis. This operation does not have a holding circuit associated with its operation, requiring that the FAST FORWARD button be held as long as the fast forward motion of the tape is required.

6-200 Pressing the FAST FORWARD button places a positive B+ voltage on terminal J12-18. If Q22 is cut off, Q23 conducts, causing Q24 to conduct and place a positive voltage at J12-V, the fast forward bus.

6-201 LOCAL SERVO TALLY AND CAMERA TALLY INDICATORS

6-202 Transistors Q15 and Q16 on the control logic board as shown in Figure 10-14 are used as a semiconductor switch to provide operating current for the SERVO LOCK lamp on the chassis, and to provide a control signal for the camera record tally indicator. This signal is generated in the control track circuitry, located in the servo section, board #14. When this signal goes to a positive potential (when the drum servo is phase locked) the base of Q15 goes positive and Q15 conducts, causing Q16 to conduct. Transistor Q16 saturates and provides current to the SERVO LOCK lamp DS1, thus indicating the recording of a correctly phased signal.

6-203 TAPE TENSION CONTROL

6-204 The tape tension control circuits include: the supply motor and brake driver, the takeup motor driver, and reel tension adjustments. These assemblies operate together to provide tape feed during record or play, fast forward tape feed, reverse tape feed, parking tension and braking of the takeup reel during rewind mode.

6-205 Because the above assemblies operate together to provide a coordinated operation, the following paragraphs discuss the circuitry in terms of the operating modes of the VR-3000 VTR. Figures 6-16 through 6-19 show the various circuits used during each of the operating modes.

6-206 STOP MODE

6-207 At the instant that the power switch for the VR-3000 is turned on, only the B+ and B- voltages are on. Figure 6-16 shows the current path to supply the motor with a

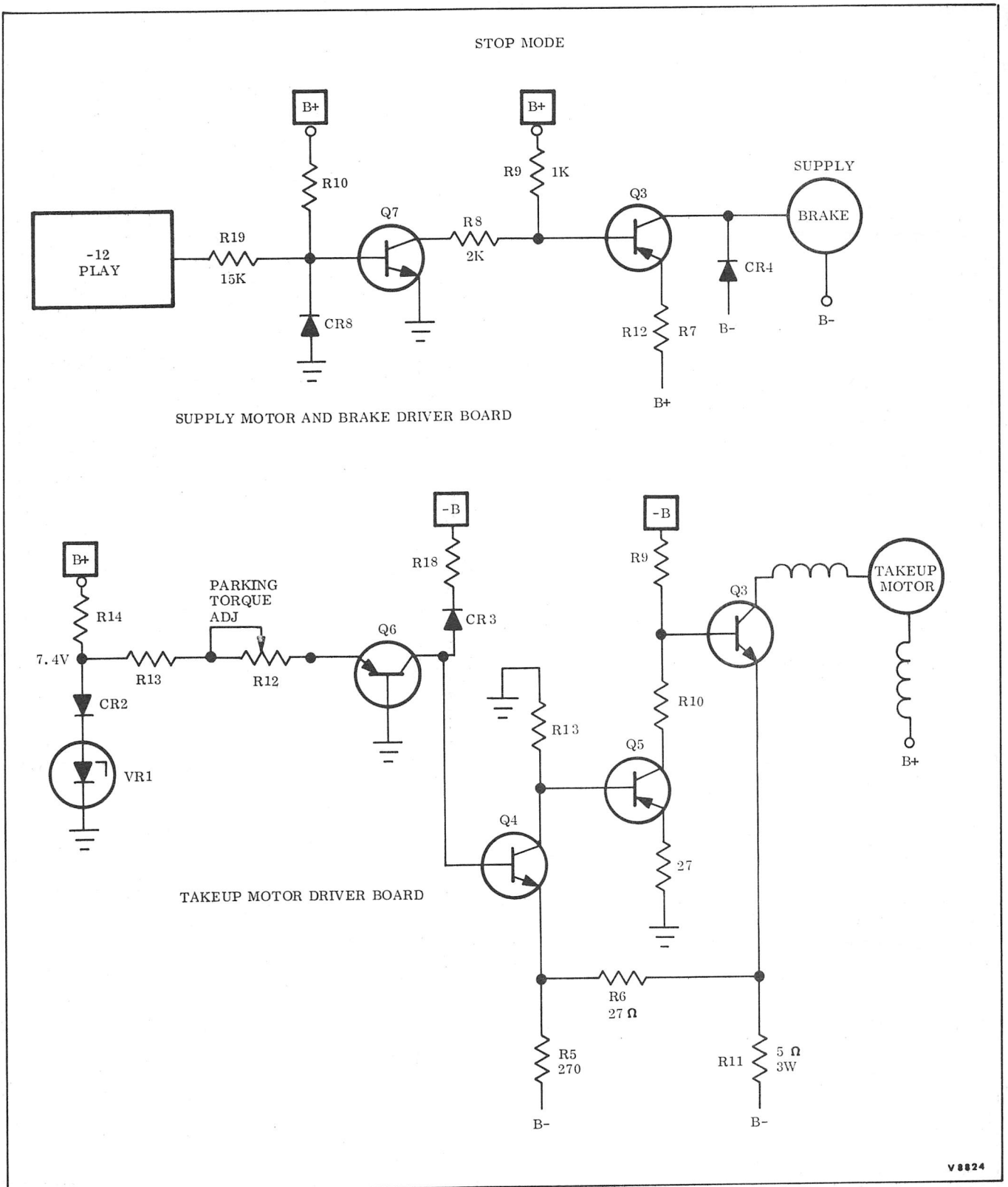
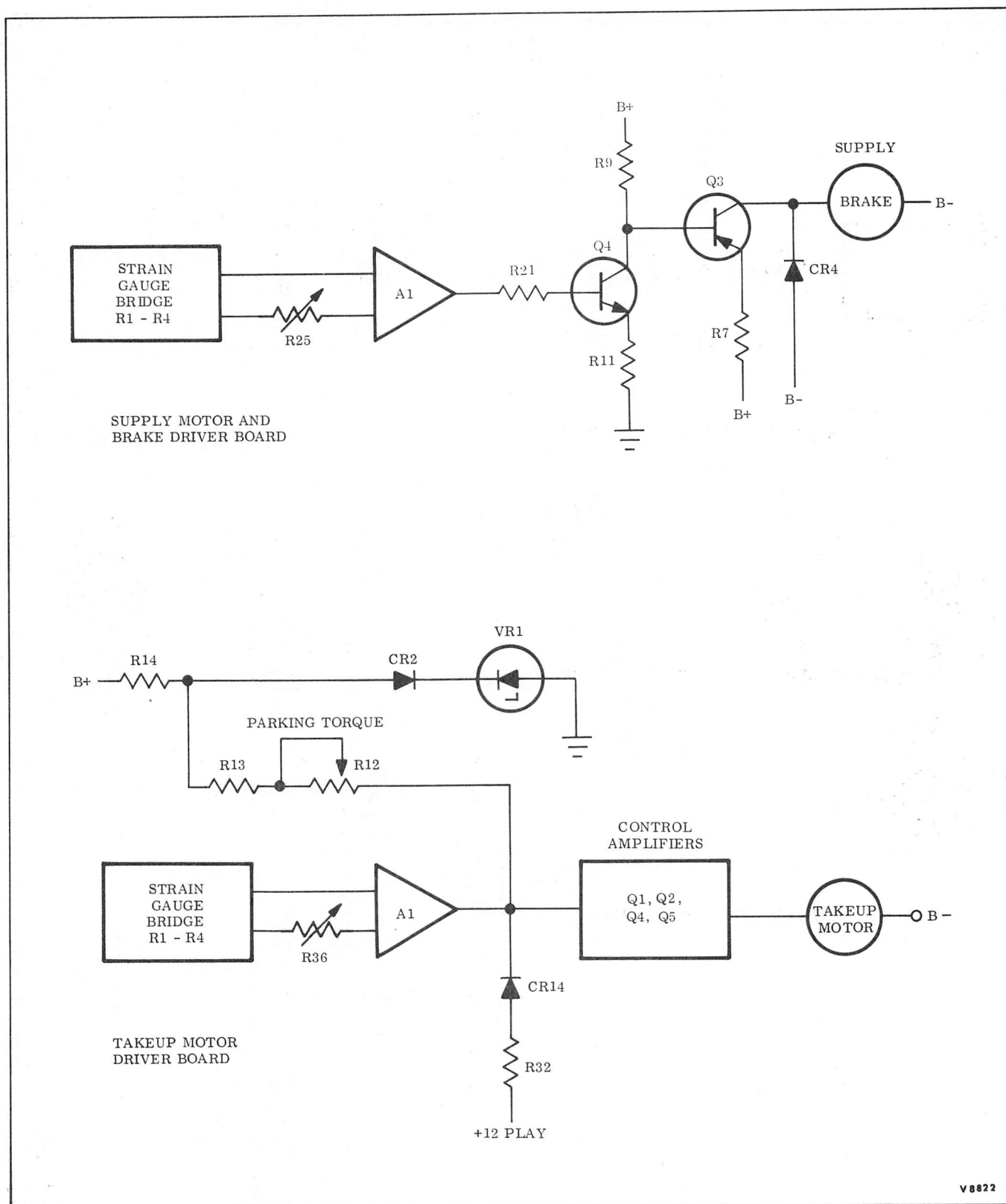


Figure 6-16. Tension Control - Stop Mode, Simplified Schematic



V8822

Figure 6-17. Tension Control - Play Mode, Simplified Schematic

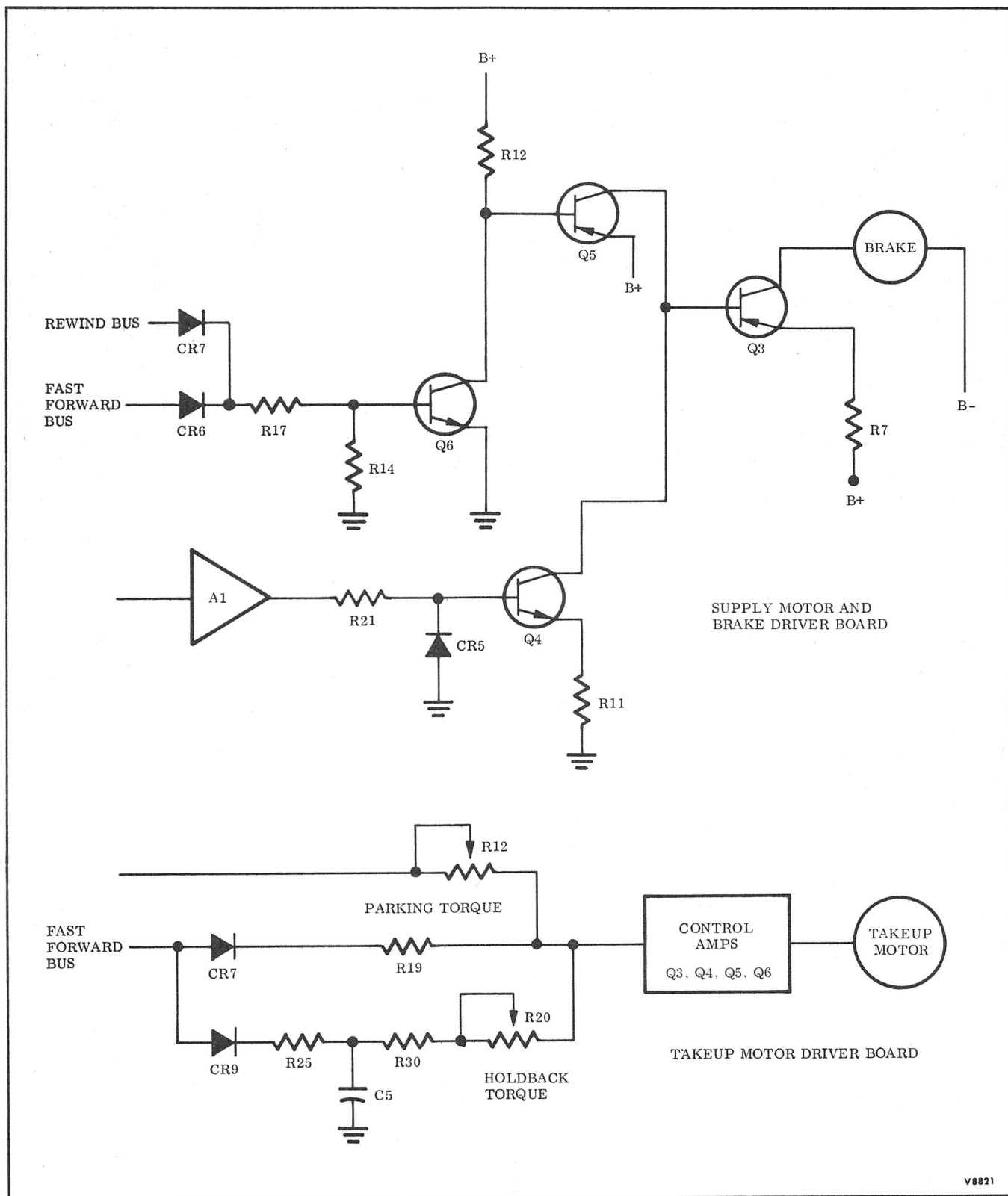


Figure 6-18. Tension Control - Fast Forward Mode, Simplified Schematic

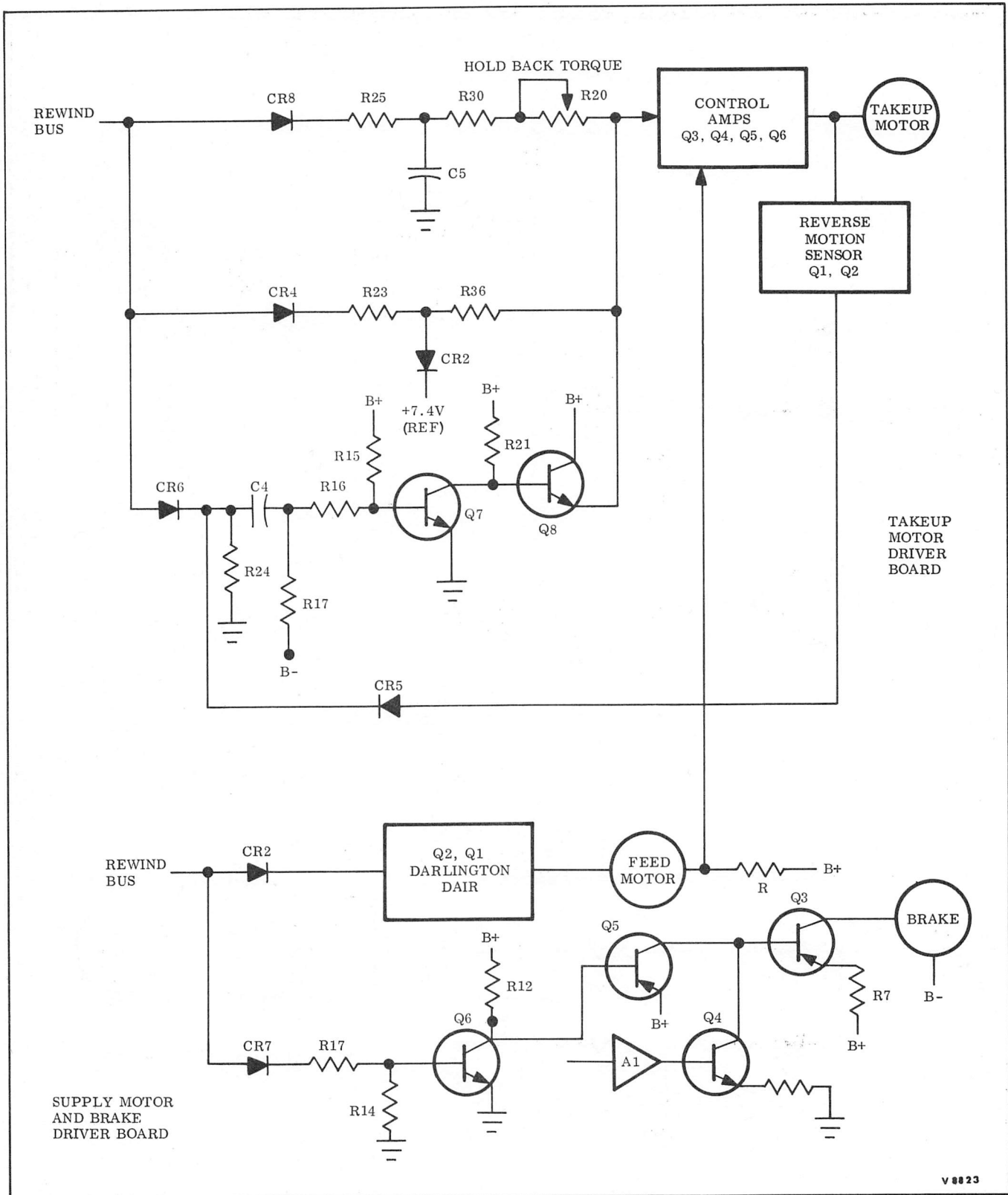


Figure 6-19. Tension Control - Rewind Mode, Simplified Schematic

nominal current to maintain taut tape. The PARKING TORQUE ADJ control R12 is adjusted so that slack in the tape path is taken up by the takeup motor assembly without removing tape from the supply reel.

6-208 The supply reel is held immobile by the parking brake associated with the supply motor and brake drivers assembly #1. This brake consists of magnetic particles in a magnetic field. When the current through the coil is small, the viscosity of the suspension is low. Conversely, when the current increases, the viscosity also increases, impeding the motion of the rotor with respect to the housing. Rotation of the supply reel is thus stopped.

6-209 PLAY MODE

6-210 In play mode, the tape is advanced at a rate of 15 inches per second. This is the function of the capstan assembly, the reel motors and the tension sensing assemblies. The takeup reel motor supplies the necessary force to move the tape in a forward direction, against an 8-ounce counter force, which is introduced by the supply reel brake, plus the frictional drag of elements in the tape path. Refer to Figure 6-17.

6-211 Nominally, at mid-reel, assuming that there is no disturbing vibration, the takeup reel torque is just adequate to move the tape at 15 inches per second; the capstan does no work. If the VR-3000 is moved or vibrated so that angular acceleration in the plane of the reels causes tape tension to change, the reels are correspondingly accelerated or decelerated by the motor to approach constant tension. Acceleration of the takeup motor is produced by increasing the motor current. Deceleration of the takeup motor is accomplished by reducing the current. Acceleration of the supply reel is accomplished by reducing the current through the reel brake. Conversely, to decelerate the tape at the supply reel, the brake current is increased. The acceleration or deceleration of each reel is determined by

sensing any change in tape tension near the associated reel.

6-212 The rate at which the reels can be accelerated or decelerated is limited by the high inertia of the reels. Thus, any large vibrations simply move the transport with respect to the reels, changing the length of the associated tape span. This change in span is accommodated without undue change in tension by the compliance of the tension arms. The instantaneous change in tension, introduced by very quick changes in acceleration of the reels, causes the capstan assembly to momentarily perform positive or negative work. The capstan is not similarly limited by the high inertia of the reels, and its capacity to accelerate is very great.

6-213 Both the takeup and supply sides of the tape path have a compliance arm assembly functioning as a tension sensor. A strain gauge is attached to the arm of each compliance assembly. This device changes its electrical resistance as the arm is deflected.

6-214 As shown in Figure 6-17, the B+ input is connected through R14 and R13 to the PARKING TORQUE adjustment potentiometer R12. This current, in addition to the current from the path consisting of +12V PLAY through CR14 and R32, and the output from operational amplifier A1, comprise the input to the emitter of Q6.

6-215 All of the above inputs, as shown in the schematic, Figure 10-19, define a voltage across R18 and CR3. This signal is connected to the base of Q4. Conduction of Q4 depends on the voltage across R11, which is a measure of motor current. Transistor Q5 is an amplifier which provides the control signal for the base of the current control transistor Q3. The takeup motor torque is a function of the current through transistor Q3 and R11, which is determined by the voltage at Q4 emitter.

6-216 As takeup tension increases, the strain gauge associated with the takeup tape loop is displaced to a larger degree, changing the resistance and unbalancing the bridge

R1 through R4 and the strain gauge. The output from the compliance assembly changes in such a manner that the output of the operational amplifier A1 decreases and reduces the torque of the motor.

6-217 In the supply side, the strain gauge bridge is adjusted to be balanced when the tape tension is measured by the strain gauge at 8 ounces. This causes the output of operational amplifier A1 to be slightly positive. Transistors Q3 and Q4 amplify any voltage change and cause the current through the brake to change.

6-218 If tape tension increases, the strain gauge is deflected and the bridge is unbalanced. The output of operational amplifier A1 changes to reflect the tension change. It is connected to the base of Q4 in such a manner that the nominal base voltage of Q4 is supplied through R21, with the operational amplifier A1 adding or subtracting from it.

6-219 FAST FORWARD MODE

6-220 The fast forward mode is a combination of all the forward drive modes, except that the operational amplifier A1 of the takeup circuit is not used to control the forward speed of the takeup motor. The motor is run at full voltage, while the brake on the supply side is fully released. The circuitry used is shown in Figure 6-18.

6-221 The control current into the amplifier Q6 on the takeup motor driver board, consists of the sum of the currents through R12, R19-CR7, R30-R25-CR8. These input currents are used to develop the full speed drive current for the takeup motor.

6-222 The supply side of the tension circuits operates to release the brake completely. This is accomplished as shown in Figure 6-18. The fast forward bus provides current through CR6 to the base of Q6, which then saturates, causing Q5 to saturate. The collector of Q5 goes to B+ and Q3 has no base current path. Thus Q3 is cut off and no brake current ensues.

6-223 REWIND MODE

6-224 The rewind mode consists of a reverse, high speed tape movement, using the takeup motor for holdback torque and a motor on the supply reel shaft to move the tape. This circuitry is shown in Figure 6-19.

6-225 On the takeup reel side: the rewind bus switches positive, diodes CR4 and CR8 conduct and provide current through R3 and R36 to the input of the control amplifiers at Q6 emitter. This input current supplies sufficient torque so that the motor generates an adequate holdback force counter to the motion of the tape. This is controlled by the adjustment at potentiometer R20.

6-226 As the takeup motor is driven backward, a reverse voltage is generated and used as the input to the reverse motion sensors, Q1 and Q2.

6-227 When the rewind mode is terminated, the rewind bus returns to zero volts. This negative-going voltage excursion is coupled through CR6 to the time constant R24, R17, R16, and C4. The negative-going pulse causes Q7 to cut off and Q8 to conduct. The input of Q6 emitter is forced positive, causing the takeup motor to increase its torque momentarily to ensure that the take-up reel decelerates as quickly as the brake decelerates the supply reel. The voltage stored on C5 continues this retardation action for a while longer. Rewinding large lengths of tape should normally be done by removing the tape from its normal threading path and allowing it to wind directly reel-to-reel. When winding tape while it remains threaded, actuation of the REWIND or FAST FORWARD relays on Board #20 connects the capstan through R1 and R2 to either B+ or B- so that the capstan motor rotates rapidly in the appropriate direction and aids in overcoming the friction encountered by the tape through the series of guides and heads.

6-228 When it is necessary to advance the tape guide only, as in the play mode, the cam

is rotated through 180° so that the guide is advanced when needed and then withdrawn when not needed. For this operation, input signal is provided through terminal E1 of board #6. Relay K1 operates, but instead of being released at the end of a transient period, the relay is held in for the complete mode. As with the case above, power is supplied to the motor through the contacts of limit switch #2. The motor continues to rotate, because K1 is held in, until the cam advances 180° , when the limit switch #2 opens and disconnects the motor current. When relay K1 is released, the current is supplied to the motor through limit switch #1, so that the motor rotates an additional 180° to withdraw the guide.

6-229 A delay circuit on the control circuit board consisting of C8, R60, R61 and

R62 maintains power to the vacuum pump, through Q25, Q26 and Q27, for about five seconds after the head drum circuits are turned off. This ensures that the tape is held away from the drum until the drum coasts to a stop. Upon restarting the drum, the application of vacuum pump voltage pulses the guide motor circuit. This same delay is used to maintain a voltage at J12-22, which provides base current to the drum motor drive transistor Q25 during operation as well as during the coasting period. The conduction of driving transistor Q25 during coasting presents the motor (acting now as a generator) with a load, causing it to slow quickly. When the vacuum pump stops (and the drum has stopped), this current is turned off to conserve power.

SECTION VII

AUDIO SIGNAL SYSTEM THEORY

7-1 GENERAL

7-2 This section contains the theory of operation for the audio signal system. The circuitry is contained on two plug-in printed circuit boards: the audio agc board and the audio head drive board.

7-3 AUDIO SIGNAL SYSTEM

7-4 The audio signal system components are located on two printed circuit boards which are connected into connectors J24 and J25. Board #24 contains the ± 10 volt power supplies, variable gain amplifiers, record amplifier, AGC amplifier and rectifiers, and headset amplifier. Board #25 contains the playback amplifier, bias oscillator, bias driver, and the connection points for the record/playback head. The circuitry for the audio signal system is shown in Figures 9-11 and 9-12. Figure 7-1 is the block diagram.

7-5 Audio input is connected through a switchable attenuation network to the input of variable gain amplifier #1. Together with variable gain amplifier #2, the gains of these two amplifiers are automatically controlled to provide up to 60 dB audio level compression. The signal is then fed to the recording amplifier where recording equalization is inserted and the signal is amplified to a level suitable for driving the record audio head.

7-6 The bias oscillator generates a 100K Hz square wave which is mixed with the

audio at the recording head. Instead, the tracking width is slightly greater than normally used in the practice of audio recording, no audio erase head is used on the VR-3000. Instead the track width is made slightly greater than is normally used. This allows the record head to erase a portion of the tape from the previous track while a recording is being made.

7-7 PLAYBACK CIRCUITRY

7-8 The audio head playback winding generates an audio signal which is connected, through relay K1-B contacts, to the input of the reproduce amplifier A2 on board #25. A feedback network consisting of R14, R20, and C3 adjusts the flat response gain of A2 and at the same time lowers the impedance of the input at A2-1 to cause it to appear as a current load for the playback signal from the head. A feedback network consisting of R11, R12, R13, and C8 serves as the playback equalization network, to approximate a flat overall playback response. The playback audio signal is gain controlled with potentiometer R7, and connected through terminals J25-4 and J24-E, through relay K1 on board #24, to the emitter follower Q2. The output of the emitter follower is connected to terminal J24-2 which is the output for a 2000 ohm headset. Playback audio output from the VR-3000 VTR is intended for preview purposes only and as such lacks full broadcast quality. (It should be noted that the recorded audio signal fully satisfies all NAB requirements for audio recording. Playback of the tape on a studio console VTR will provide high quality audio output.)

7-9 RECORDING CIRCUITRY

7-10 The recording circuits consist of an input attenuator, variable gain amplifier #1, variable gain amplifier #2, record amplifier including equalization network, AGC circuits and AGC decay (timing) circuits.

7-11 INPUT ATTENUATOR. Audio input to the VR-3000 VTR is made through connector J2, to the input attenuator. Attenuator of 0 dB, 26 dB or 52 dB may be selected with switch S1. This switch also switches the AGC signal to provide the functions as listed in Table 7-1.

Table 7-1. Audio Input Switch Functions

Switch Position	Function	Attenuator Loss	AGC Operation
1	LINE AGC OFF	26 dB	No
2	LINE AGC	52 dB	Yes
3	MIC	0 dB	Yes

7-12 VARIABLE GAIN AMPLIFIER #1.

The input signal from the attenuator is coupled through transformer T1 to the bases of dual transistor Q11. Resistors R22 and R50 serve as a simulated center-tap for the secondary winding of T1, and also to serve as the base return resistances. The input signal is thus split so that the signal across R22 is the complement of the signal across R50. Potentiometer R51, in series with resistor R46 serve as a coupling impedance between the two emitters. Field-effect transistor Q10 serves as a variable impedance, shunting the fixed impedance of R51 and R46. As the stage gain is determined by the ratio of collector impedance to emitter impedance, decreasing the impedance of Q10 increases gain of the stage.

7-13 The drain-source impedance of the field effect transistor Q10 is controlled by the dc bias placed at its gate element. As the voltage becomes more positive, the internal impedance of the device decreases.

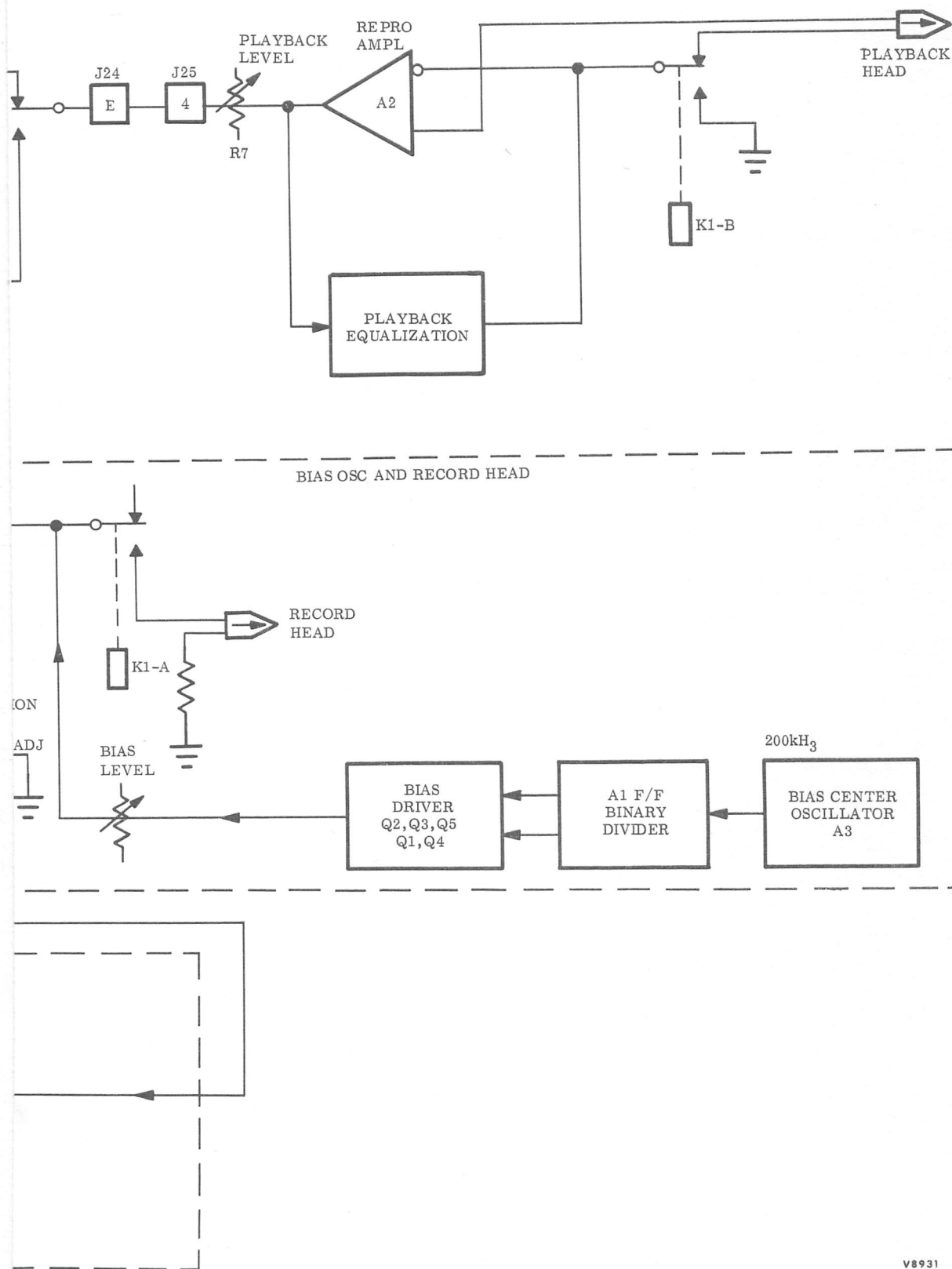
7-14 VARIABLE GAIN AMPLIFIER #2.

Variable gain amplifier #2 consists of dual transistor Q8 and variable impedance device Q9. The output signals from the two halves of variable gain amplifier #1, at the collectors, are connected to the respective base element of Q8. In a manner similar to that

of Q10 and Q11, the gain of this amplifier is controlled by the dc bias presented to the gate element of field-effect transistor Q9. As signal level increases, variable gain amplifier #1 reduces gain first followed by amplifier #2 which begins to act when #1 has run out of its control range.

7-15 OUTPUT AMPLIFIER (RECORD AMPLIFIER). The output amplifier is located on board #24 and consists of operational amplifier A3. The input signal consists of the complementary signals from the collectors of Q8. The dc gain of amplifier A3 is determined by the ratio of the resistances of R21 and R26. A feedback network of R43 and C18 serves to boost the audio spectrum slightly at the 100 Hz point, so as to produce the NAB low frequency boost in the overall record curve. Record equalization is produced by an RC circuit consisting of C22 on board #24, and R18, R6 on board #25. Equalization provides a rising response with rising frequency. Potentiometer R6 adjusts the threshold point where the knee of the curve occurs, as well as the magnitude of the boost.

7-16 A sample of the record audio voltage is coupled through capacitor C16, to the record contact (NC) of relay K1. The recorded audio signal may thus be monitored in the headset.



V8931

Figure 7-1. Audio Signal System

7-17 The record audio signal is coupled through C6 to connector J24-3, through J25-2, to the record level adjust potentiometer R4. Inductor L1 and capacitor C2 on board #25 serve as a bias trap, preventing the bias frequencies being loaded down by the output circuitry of the audio signal. Bias adjustment is performed by potentiometer R1. The bias signal and audio signal are combined in the record winding of the audio head.

7-18 AGC AMPLIFIER AND RECTIFIER. A sample of the record audio from the output of amplifier A3 on board #24 is coupled to potentiometer R10, which is the AGC LEVEL adjustment. Dual transistor Q5 serves as a differential amplifier and serves to split the signal into two signals 180 degrees out of phase. The collector outputs are directly connected to the bases of Q6 and Q7 respectively. Both sides of Q5 are conducting within their linear range. Assuming that a large positive excursion in the audio waveform appears across R10, the side of Q5 associated with Q6 begins to conduct heavier. Because the collector voltage of Q6 cannot decrease below 5.4 volts, no change occurs at the base of Q6. But, the increase in current through the half of Q5 is compensated by a decrease in current through the half of Q5 associated with Q7. If the voltage excursion is great enough to overcome the clamp voltage introduced by VR4, the base voltage of Q7 rises, accompanied by a corresponding rise of the emitter voltage of Q7.

7-19 When the large voltage excursion as described above is negative instead of positive, a similar operation occurs, but at the base and emitter of Q6 instead of Q7. Normally, with no audio input, the emitters of Q6 and Q7 remain at the clamp voltage of 5.4 volts, minus the base-emitter junction voltage drop of 0.6 volt, or approximately +4.8 volts. Diodes CR1 and CR2 serve as a cross coupling, to connect the two AGC decay lines. The higher positive voltage (comparing the emitter voltages of Q6 and Q7), will be maintained on both lines.

7-20 AGC DECAY. Four time constants are used for the two AGC lines. Each of

these time constant circuits when charged, serves to keep the AGC voltage at the positive potential for its time constant. The emitter of Q6 is connected directly to capacitor C11, and to capacitor C12 through resistor R31. Small voltage swings at the emitter of Q6 quickly charge the capacitor C11, but charge capacitor C12 more slowly. Discharge of these capacitors, on the other hand, must be through resistor R28 which has a relatively large resistance. Therefore, the discharge time is much greater than the charging time. If very large voltage excursions occur, capacitor C11 charges quickly to the peak voltage but capacitor C12 charges to a lesser potential depending on the amplitude and duration of the voltage transient. The discharge time of the AGC circuit depends on the total charge in both capacitors and becomes greater for larger and longer voltage excursions. Consequently as the background sounds become more sustained and louder, the AGC discharge time constant is automatically made longer. The timing circuits associated with Q7 also operate in this manner. One half of the AGC decay circuits respond to positive voltage excursions while the other half of the circuit responds to the negative voltage excursions.

7-21 GAIN CONTROL CIRCUITS. The gain control circuits Q9 and Q10 serve to couple the signals, at each emitter of the differential amplifiers Q8 and Q11 respectively, to the other emitter of the same device. Because of the large emitter resistors in the respective emitter circuits, degeneration of the audio signal occurs, and each output at the associated collector is reduced greatly. Cross-coupling of signals is performed through the variable impedance of the field-effect transistor; the degenerative action is cancelled and the gain of each variable gain amplifier increases with a decrease of coupling impedance.

7-22 Quiescent bias for each variable gain amplifier is adjustable with the BIAS ADJUST NO. 1, (R44) and BIAS ADJUST NO. 2, (R38). These controls set the threshold point at which the shunt impedances of Q10 and Q9

begin to be increased. When the average audio level is increased, the AGC voltage becomes more positive. The positive excursions of the AGC voltage increase the shunting impedance of Q10 and Q9, progressively so that amplifier #1 decreases gain then amplifier #2 decreases gain.

7-23 BIAS OSCILLATOR. The ac-bias oscillator consists of operational amplifier A3, flip-flop A1, and bias driver circuitry Q1, Q2, Q3, Q4, and Q5. All circuitry is located on board #25.

7-24 Operational amplifier A3 is connected as a 200K Hz oscillator having an output signal at A3-5. Flip-flop A1 serves as a divide-by-two binary counter which provides a

symmetrical 100K Hz square wave signal at its outputs A1-7 and A1-5. The output at A1-5 is connected to the base of transistor Q3. The output at A1-7 is the inverted version of the signal at A1-5 and is connected to the base of Q2. The signal at the emitter of Q3 is connected to the emitter of Q5 through resistor R10. Transistor Q1 saturates on alternate half cycles of flip-flop A1 output to pull the junctions of transistors A1 and Q4 toward the +10 volt power supply. On the remaining half cycles, Q4 saturates to pull the junction of Q1 and Q4 toward the -10 volt power supply. Thus, the ac bias voltage, coupled through C1, alternately switches between +10 and -10 volts. Potentiometer R1 is used to adjust the level of bias current injected into the audio head.

SECTION VIII

POWER SUPPLY THEORY

8-1 GENERAL

8-2 This section contains the theory of operation for the +3.6 volt power supply, the ± 10 volt power supply, ± 12 volt power supply, power distribution chassis, battery eliminator, battery pack, and battery charger. Checkout and charging procedures for the battery pack are located in Section IX under the heading of Battery Pack.

8-3 3.6 VOLT POWER SUPPLY

8-4 The 3.6 volt power supply is located on the printed wiring assembly #3, and is shown in Figure 10-16. Input to the 3.6 volt power supply consists of +12V SVO and -12V SVO for use as the regulator operating voltages, and B+ input which is reduced in voltage and regulated at +3.6 volts dc.

8-5 The 3.6 volt power supply includes a 30K Hz square wave oscillator A1, ramp generator Q1, comparators A2 and A3, regulator circuitry Q3, Q4, and Q5, and an overcurrent sense circuit Q2. Figure 8-1 shows a block diagram of the 3.6 volt power supply; Figure 10-16 is the schematic. Filter circuitry is also included and consists of inductors L1, L2, and L3 capacitors C1, C2, C3, and C4 and filter FL1.

8-6 The regulator circuit switches its output, at Q4 emitter, from the B+ voltage to ground at the rate determined by the oscillator. The ratio of the on-time to the total cycle time of the pulse is controlled so that the average voltage is 3.6 volts while the peak voltage is B+. This is a pulse width control type voltage regulator.

8-7 The oscillator circuit A1 is a free running, 30K Hz, square wave generator. Capacitor C6 and resistor R7 form a differentiator circuit. Each positive going edge of the square wave input causes Q1 to saturate for an instant and discharge capacitor C1, which is the timing capacitor. At the end of this transient pulse edge, Q1 cuts off and the capacitor C1 begins charging toward +12 volts, through resistor R1. The ramp continues up to approximately 3 volts, at which time the positive going edge of the square wave from the oscillator discharges C1 and the cycle starts again.

8-8 The ramp signal is connected to one input of comparator A3, at terminal A3-2. The second input to the comparator at A3-3 is controlled dc voltage, which is discussed in the paragraphs below. The output of the comparator at A3-7 is a constant voltage pulse train containing pulses which switch positive at the instant when the ramp voltage is equal to the controlled input voltage at A3-3, and switch negative at the instant that the ramp is reset. The comparator A3 controls the effective cross-over point of the ramp to produce a variable pulse width pulse train.

8-9 When A3-7 is positive, transistor Q3 conducts, causing Q5 to conduct and Q4 to conduct. This connects the B+ to the regulator output. When A3-7 is at 0 volts, the regulator transistor Q4 is cut-off and the B+ is disconnected.

8-10 Comparator A2 is used to derive the control voltage for comparator A3. Inputs to comparator A2 consist of a manually

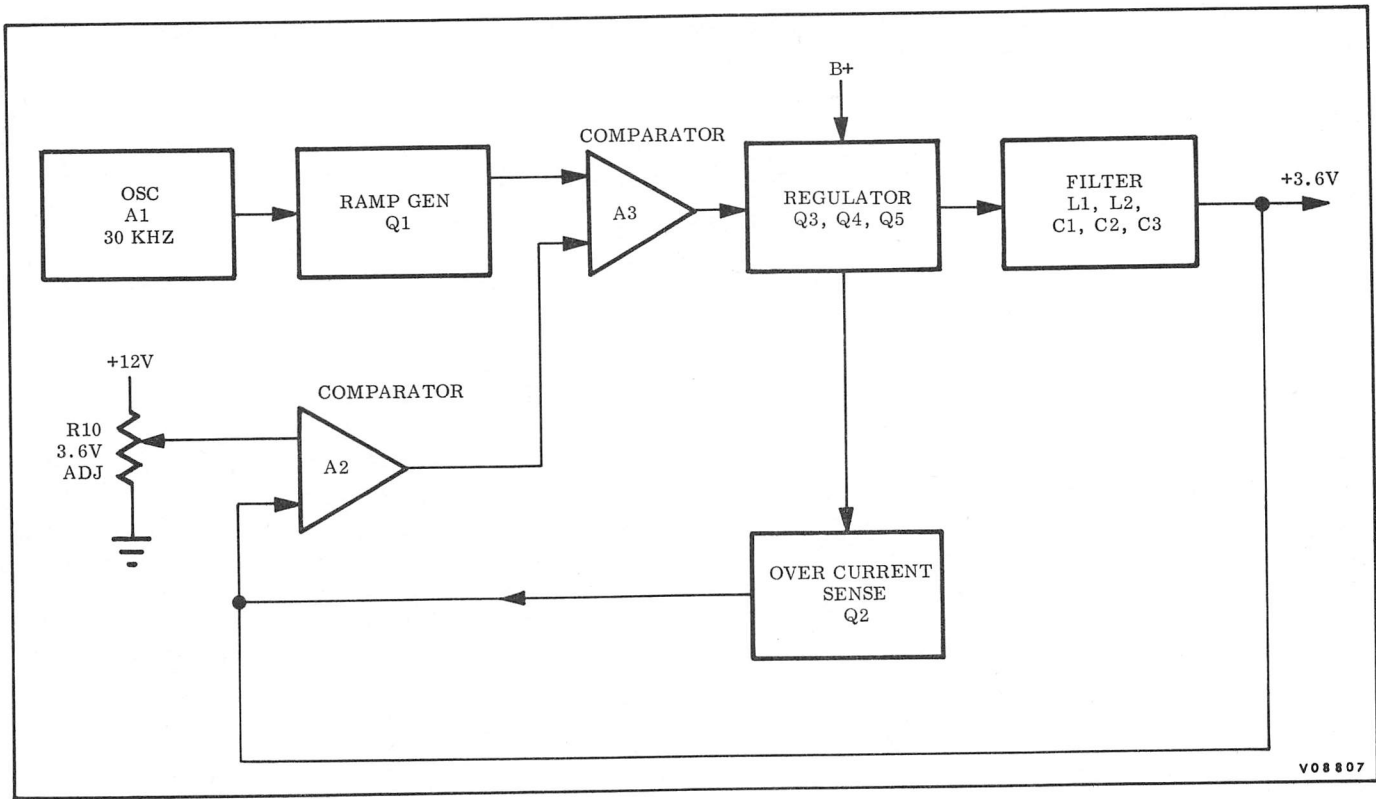


Figure 8-1. +3.6 Volt Power Supply

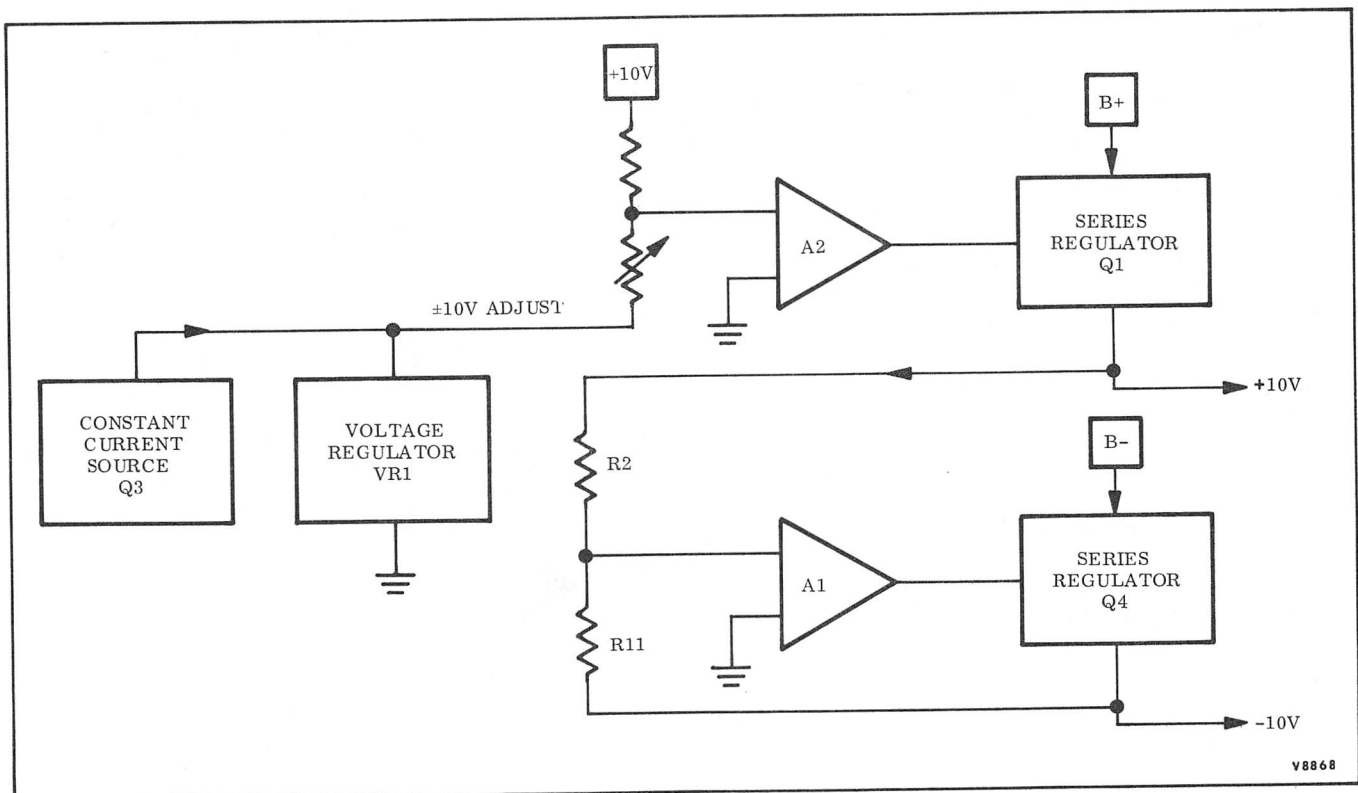


Figure 8-2. ±10 Volt Regulators

adjusted reference voltage at A2-2 (R10) and a sample of the output voltage, after filtering, at A2-3. The two dc voltages are compared and the difference voltage is amplified to generate the control signal at A2-6. Voltage regulator diode VR2 is a voltage surge suppressor.

8-11 The overcurrent circuit consists of transistor Q2. If the current through the regulator transistor and resistor R20 exceeds one ampere, the voltage drop across resistor R20 becomes great enough for transistor Q2 to conduct. The collector, under this condition, starts to change its voltage toward the B+ level, which has the effect of reducing the 3.6 volts at the output, to maintain the maximum current at one ampere.

8-12 ±10 VOLT POWER SUPPLIES

8-13 The ±10 volt power supplies are used to provide dc power to the audio section of the VR-3000 VTR. These circuits function basically as series regulating elements in the respective battery line to reduce and regulate the B+ and B- voltages for use in the audio circuits. The positive regulator uses a zener diode derived voltage as reference and compares its output with it. The negative regulator uses a sample of the positive voltage as reference to regulate the -10 volt output. Figure 8-2 shows the block diagram of the + and - regulators.

8-14 ±10 VOLT REGULATORS

8-15 The circuitry for these regulators is contained on the audio AGC board #24. The schematic is shown in Figure 10-11. Transistor Q3 is connected with diode VR2 as a constant current source, providing operating current for voltage regulator diode VR1.

8-16 The ±10V ADJ potentiometer R1 is used to set the voltage at the input of operational amplifier A2-1, so that the output at A2-5 is slightly more positive than the output voltage at Q1-E. Any change in the +10 volt output causes the voltage at voltage divider (junction of R6 and R13), to change

and provide a corresponding change at the output of A2-5.

8-17 The -10 volt regulator consists of the operational amplifier A1 and series regulating element Q4. The voltage divider consisting of resistors R2 and R11 provides an error voltage to the input at A1-1. When the +10 and -10 volt outputs are equal, then the output of A1-5 is in its linear control region. Any change in the +10 volt regulator output is reflected as a corresponding change in the magnitude of -10 volt regulator output.

8-18 If the +10 volt load changes, it is accommodated by the +10 volt regulator; correspondingly, any change in the -10 volt load is provided for by the -10 volt regulator. The -10 volt output always tracks the +10 volt output.

8-19 ±12 VOLT POWER SUPPLIES

8-20 The ±12 volt regulator circuitry is located on board #11 and is shown in Figure 10-17. This circuitry consists of a +12V SVO regulator, a -12V SVO regulator, a +12V SIG regulator, and a -12V SIG regulator. The positive regulator circuits accept the positive battery voltage and regulate the outputs at +12 volts, ±20 millivolts. The negative voltage regulators accept the negative battery voltage and regulate the outputs at -12 volts, ±20 millivolts.

8-21 The ±12V SVO voltages are turned on in all operating modes. This is defined in the control logic circuits as the "SERVO SUPPLY CONTROL SIGNAL". The ±12V PLAY voltages consist of the SVO voltages which are switched on during play mode by relay K1 on board #11.

8-22 The ±12V SVO voltages are turned on only when needed. This demand is initiated by the control logic circuits and consists of a positive voltage at the record/ready bus or the play bus. Each pair of the four regulators operate independently. If the -12 volts from either the SVO or SIG regulators is present, the corresponding +12 volt

regulator is switched on. Conversely, if a negative voltage is missing, the corresponding positive 12 volt regulator is switched off.

8-23 ± 12 VOLT SVO REGULATORS

8-24 The ± 12 volt SVO regulators are shown in Figure 8-3 in block diagram form. The negative regulator consists of differential amplifiers Q9 and Q8, amplifier Q5, series regulator Q1, overcurrent sensor Q6, and logic control Q11.

8-25 Transistor Q9 is a dual semiconductor device which is operated as a differential amplifier. The constant current diode CR6 sets a specified current through Q9. Variations of the -12V supply are detected through potentiometer R26 by Q9 and compared against the temperature compensated zener diode VR2. The difference voltage is amplified by Q9 and further amplified by differential amplifier Q8. Transistor Q8 controls the emitter follower transistor Q5, which drives the series regulator transistor Q1.

8-26 Transistor Q11 is normally in the conducting state. The presence of a positive voltage at the servo supply control, terminal J11-J, causes Q11 to cut-off and remove its shunting effect from the base of Q8. This allows the -12 volt regulation loop to become active and provide an output of -12 volts. When the VR-3000 logic circuits request the -12 volts (SVO), Q11 is used to switch the power.

8-27 The overcurrent circuit serves to limit the maximum current of this regulator to a predetermined safe value. If the current through the regulator transistor Q1 exceeds the preset value, the voltage drop across resistor R15 becomes great enough to allow Q6 to conduct. This action pulls the base voltage of Q5 toward the -B potential, reducing the current in Q5. Through emitter follower action, the voltage at the base of Q1 moves toward B- and the voltage drop across Q1 is correspondingly reduced, reducing the series current.

8-28 The plus regulator consists of the differential amplifiers Q12 and Q14, amplifier Q15, series regulator Q17, overcurrent sensor Q16, starter Q13, and control switch Q10.

8-29 This regulator operates in a similar manner to the -12 volt regulator, except that the regulator is switched on and off by using a sample voltage from the -12 volt regulator. A start-up circuit is included to start the regulator circuits functioning when -12 volts is sensed, and switch itself out of the circuit when +12 volts is established.

8-30 The startup circuit consists of transistor Q13 with a sample of the +12 volt SVO voltage at the base. When this voltage is missing, at the times when the +12V SVO regulator is not functioning, transistor Q13 is cut-off and the B+ voltage, through resistor R32 and diode CR11, is able to reach the base of transistor Q14. This is the start-up voltage. After the +12 volts is present, it is no longer necessary for this current path to exist. Transistor Q13 conducts and pulls the anode of diode CR11 to ground.

8-31 ± 12 VOLT SIG REGULATORS

8-32 The plus and minus signal (SIG) regulators are located on the regulator assembly board #11. The circuits operate in a similar manner to that of the SVO regulators. This is shown in the block diagram Figure 8-4. The source of logic control for the 12V SIG regulators is an OR gate composed of diodes CR9 and CR10. If either the play mode or the record/ready mode is established, the -12 volt SIG regulator is enabled; otherwise the regulator is disabled. The +12 volt SIG regulator is switched on by the presence of the -12 volt output of the -12V SIG regulator.

8-33 Because of the higher current demands from these regulators, the series regulating elements are mounted external to the regulator board #11. They then have a higher power dissipating capability.

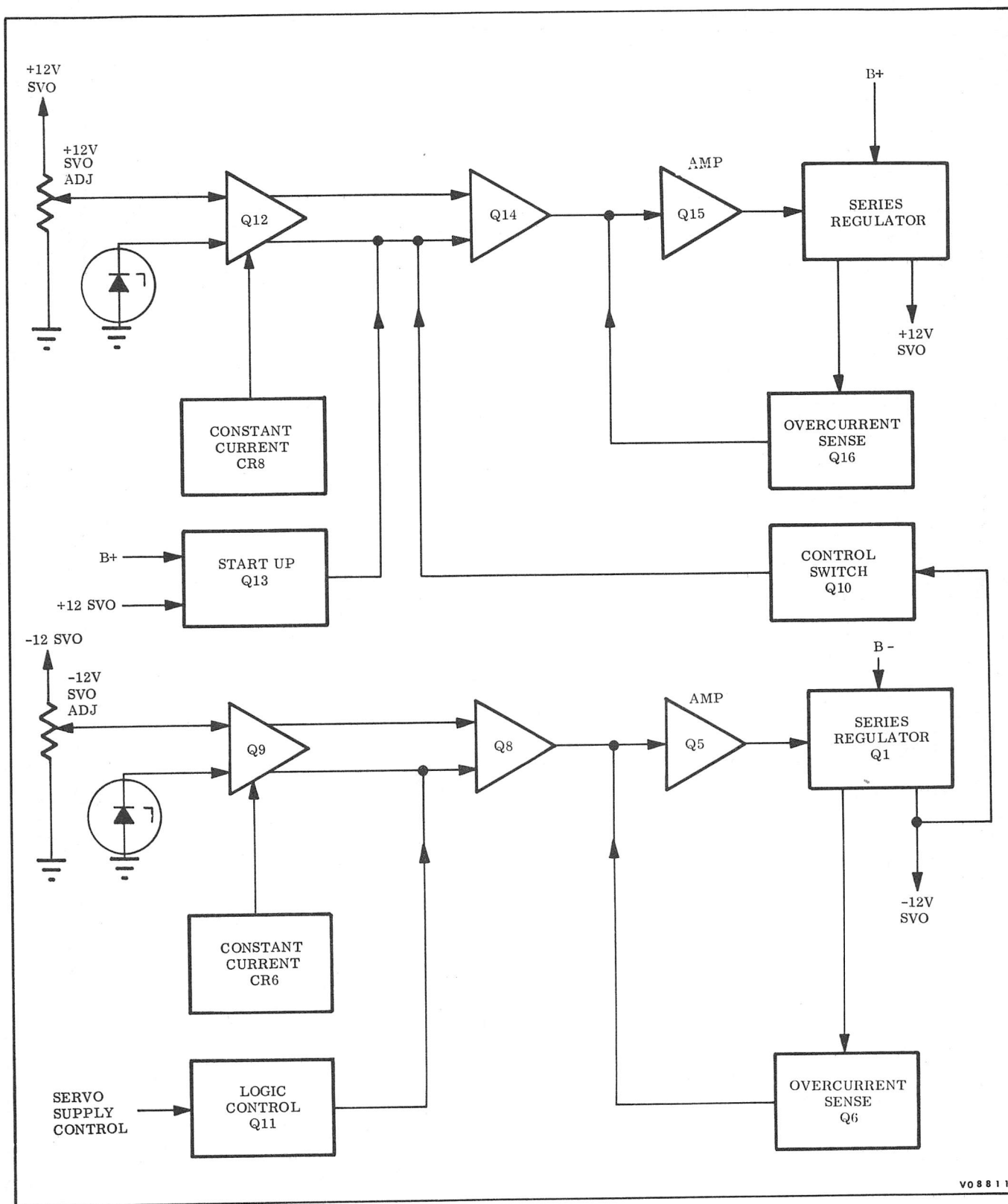


Figure 8-3. ±12 Volt SVO Regulators

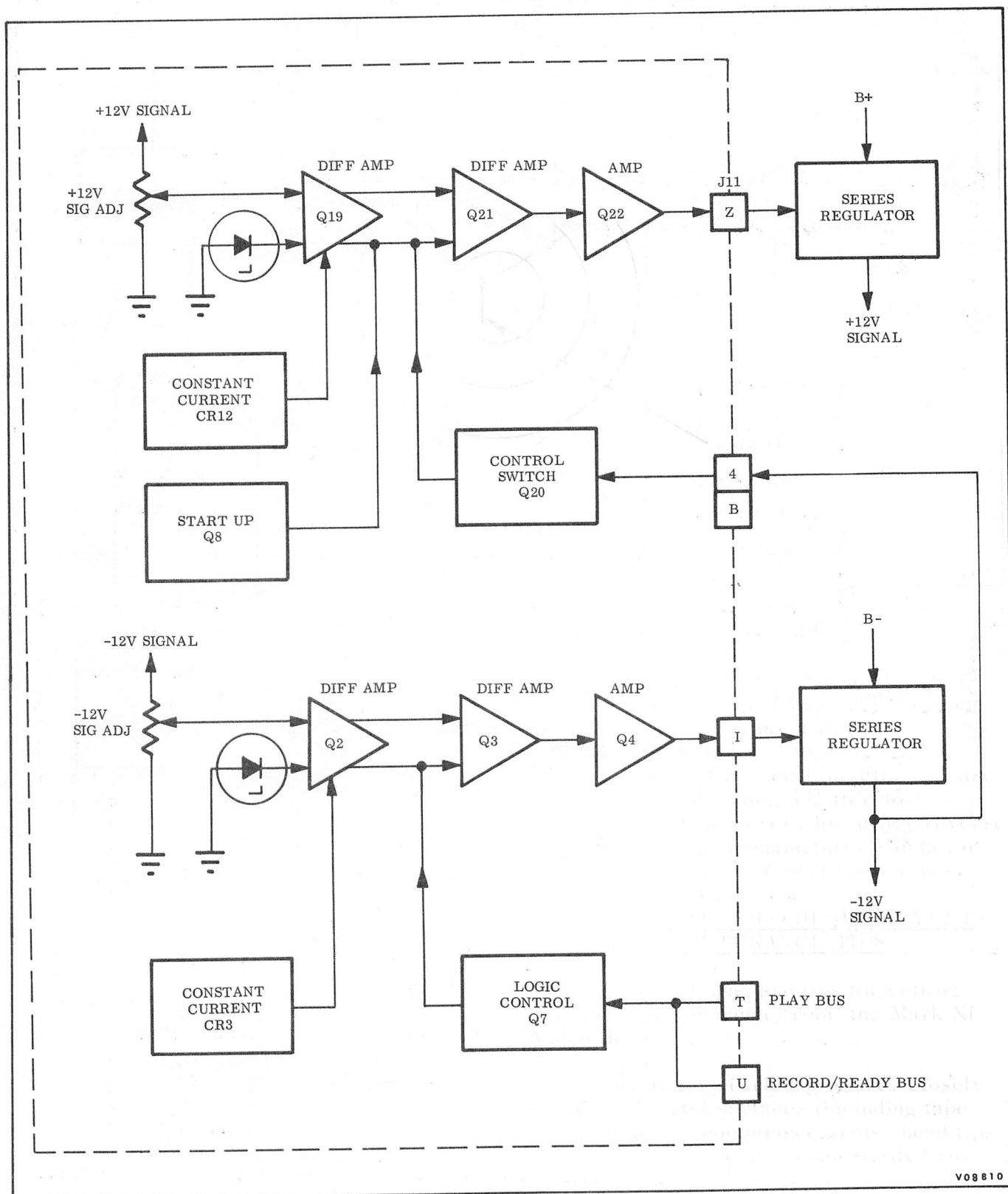


Figure 8-4. ±12 Volt SIG Regulators

8-34 The -12V SIG regulator consists of differential amplifiers Q2 and Q3, amplifier Q4, and logic switch Q7. The series regulating transistor Q1 is mounted on the chassis.

8-35 The +12V SIG regulator consists of differential amplifiers Q19 and Q21, amplifier Q22, starter Q18, and control switch Q20. The series regulating transistor Q2 is mounted on the chassis.

8-36 POWER DISTRIBUTION

8-37 The power distribution board is shown in Figure 10-15 and consists of four relays and associated circuitry. These relays are operated to switch operating power (voltages) between the various functional circuits in the VR-3000 to have power available for the required circuits during each of the operating modes. Input signals for the power distribution board are derived in the circuitry on the control logic board. These signals operate the various relays either individually, or in combinations. Table 8-1 lists the operating modes which are introduced when the associated relays are operated. The outputs from the power distribution board are used to control the voltages in the plus and minus 12 volt power supplies, specific operating functions in the VR-3000, and the plus battery voltage.

8-38 BATTERY ELIMINATOR

8-39 The battery eliminator is an ac powered, 30 volt, regulated dc power supply. The output voltage is center tapped to provide +15 and -15 volts for use in place of the battery pack voltages. Refer to the block diagram, Figure 8-5, and the schematic, Figure 10-30.

8-40 The battery eliminator includes a dual-primary winding input transformer, full wave bridge rectifier, filter, voltage regulator, and voltage balance regulator. Input is either 115 volts, 50/60/400 Hz, or 220 volts, 50/60/400 Hz. Output consists of two voltages, namely +15 volts dc and -15 volts dc. Because the load requirements of the VR-3000 (B+ and B- input currents) are nearly balanced, the battery eliminator series-regulates the input voltage, from the filters, from approximately 46 volts (measured from the plus filter to the minus filter) to 30 volts. Then, through the use of the shunt, dynamic impedance elements center tap the 30 volts so that the output voltages with respect to ground become +15 and -15 volts respectively.

8-41 POWER INPUT

8-42 Depending on the input voltage available, either of the two connecting

Table 8-1. Power Distribution Relay Operation

Mode	Relay			
	K1	K2	K3	K4
Record	Operated	Operated	Released	Released
Play	Released	Released	Released	Released
Record/ready	Released	Operated	Released	Released
Fast Forward	Released	Released	Released	Operated
Rewind	Released	Released	Operated	Released

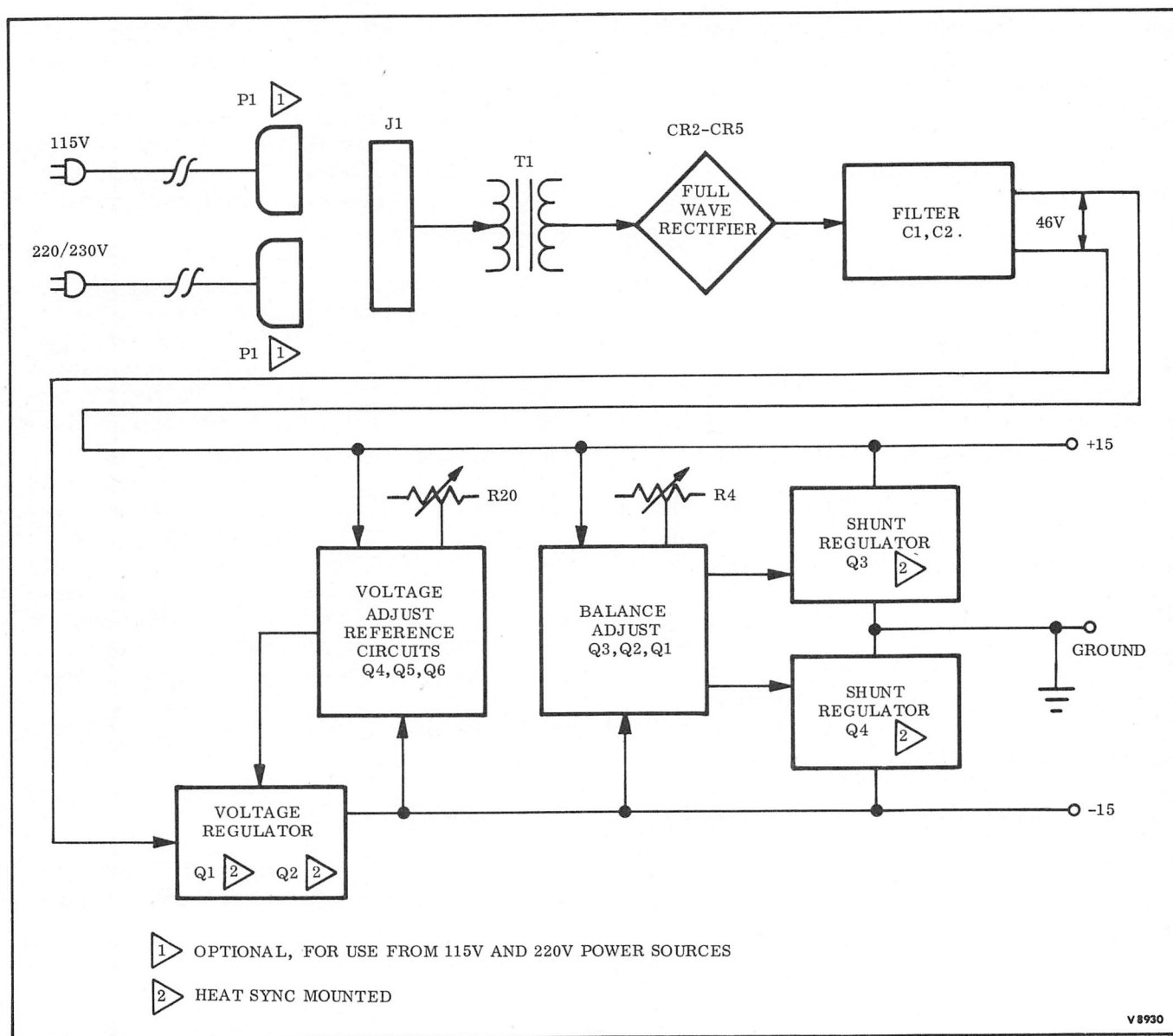


Figure 8-5. Battery Eliminator

cables is connected to the input terminal J1. For 115 volt input, terminals 1 and 2 are jumpered together in the 115V connector; terminals 3 and 4 are also jumpered together, with the effect of paralleling the two input windings of T1. For 220 volt operation, the 220V interconnecting plug provides jumpers so that the two windings are placed in series. Output from the secondary winding of T1 is an ac voltage of 33 VRMS. Bridge

rectifier CR2, CR3, CR4, and CR5 full-wave rectify the output of transformer T1 to produce a dc output of 46 volts across the filter capacitors C1 and C2.

8-43 VOLTAGE REGULATOR

8-44 The voltage regulator series regulating element consists of two head sink mounted transistors Q1 and Q2. Transistors Q4 and Q5 are connected as a differential

amplifier, with the base of Q5 connected to a voltage sampling network (adjustable). The base of Q4 is connected to the zener reference voltage, VR1. The regulating action of the supply is as follows; if the 30 volts is low, the voltage at the base of Q5 is more positive than the reference voltage, Q5 conducts less and Q4 conducts more. This causes Q6 to conduct harder, which, in turn, causes Q1 and Q2 to allow greater current to flow. The output voltage then increases.

8-45 Correspondingly, a decrease in the relative positive voltage at the base of Q5 causes Q4 to conduct less, transistor Q6 to conduct less, and Q1, Q2, on the heat sink, to conduct less (increasing its voltage drop). Because all voltage excursions of the relative voltage are performed on the negative output line, with reference to the positive output line, the voltage difference adjustment tends to return the output voltage difference between the two lines to 30 volts. The output voltage is adjusted with R20 to be 30 volts.

8-46 BALANCE SHUNT REGULATORS

8-47 The output as described above consists of a regulated source of 30 volts, without any reference to ground. In order to have two regulated voltages of -15 and +15 volts, from the 30 volt supply, a ground return is inserted through the use of two controlled load shunts which are reference to ground. Each of the shunt regulators introduces additional loading on its respective side of the 30 volt supply (in addition to the +15 volt and -15 volt loads) so that the total current consisting of the +15 volt load and its shunt load is equal to the total current from the -15 volt load and its shunt load (both total loads are referenced to ground).

8-48 Transistors Q3 and Q4, on the heat sink, are used as the two shunt impedance elements. Control signals for the base elements of Q3 and Q4 are derived at the collector of Q1 on the printed circuit board. Transistor Q3 is a dual device which is connected as a differential amplifier. Transistors Q1 and Q2 are also connected as a differential amplifier. Potentiometer R4 is used to adjust the dc balance of the shunt

impedances with respect to ground. Assume a condition where the loads for the positive and negative voltages become unequal and tend to change the +15 volts toward +16 volts, and change the -15 volts toward -14 volts. Because of the overall voltage shift toward positive, the slider in R4 becomes more positive. The differential action of Q3 causes transistor Q1 conducts more while transistor Q2 conducts less. Because the transistor Q1 conducts more, its collector is pulled toward the positive output voltage. Transistor Q4 at the heat sink conducts more and transistor Q3 conducts less. The grounded balance point is pulled toward the positive output line and thus, the balance is re-established.

8-49 BATTERY PACK

8-50 The battery pack used in the VR-3000 VTR consists of 30 semi-sealed silver cadmium cells. Each three cell group is assembled into a three cell battery; ten such batteries comprise one battery pack. The positive electrode is silver, while the negative electrode is cadmium. The electrolyte consists of a strong solution of potassium hydroxide.

8-51 The batteries are equipped with pressure relief valves which open in case of accidental pressure build-up within the cell. After the pressure has been released, the valve closes. If the battery is not subjected to excessive currents, either during charge or discharge, no pressure build-up is expected.

8-52 CHARGING PROCEDURES

8-53 For optimum performance of the battery, it is recommended to only charge the battery using the battery charger which is supplied in the accessory case. The battery manufacturer's recommended charging procedure requires that the individual batteries comprising the battery pack be charged separately while each battery terminal voltage is monitored. Also, the maximum charging current and end-charging voltage must be strictly observed. These

operations have been designed into the operation of the charger. Refer to Section X for the battery charging procedures. See Figure 8-6 for a typical battery charging curve.

8-54 STATE OF CHARGE

8-55 The fully charged battery pack has an open circuit voltage of 41.5 to 42.5 volts. When 25% of the capacity is discharged, the open circuit voltage drops to 35 volts. Continued discharge reduces the voltage slightly, until the battery pack is completely exhausted. At complete exhaustion, the terminal voltage is less than 27 volts for a discharge rate of 2 amperes. See Figure 8-7 for a typical battery discharge curve.

8-56 BATTERY INTERCONNECTIONS

8-57 Each battery in the pack is connected to a wiring harness with two screw terminals, which connect the individual batteries to the

battery pack connector. The output from each battery is accessible, at the connector; each cell is charged individually. Jumpers are included in the connector, located at the charger, to connect the five negative battery terminals and the five positive battery terminals, respectively. This is done to economize on battery connector terminals. The remaining terminals are each assigned to an individual battery.

8-58 During use, in the VR-3000 VTR, the individual batteries are used in series by providing jumpers in the VTR connector. Thus, full battery pack voltage is available for use. The battery is operated with a ground tap at its electrical center, providing +20 volts and -20 volts to the VTR.

8-59 BATTERY CHARGER

8-60 The battery charger is a self contained unit, located in the accessory field

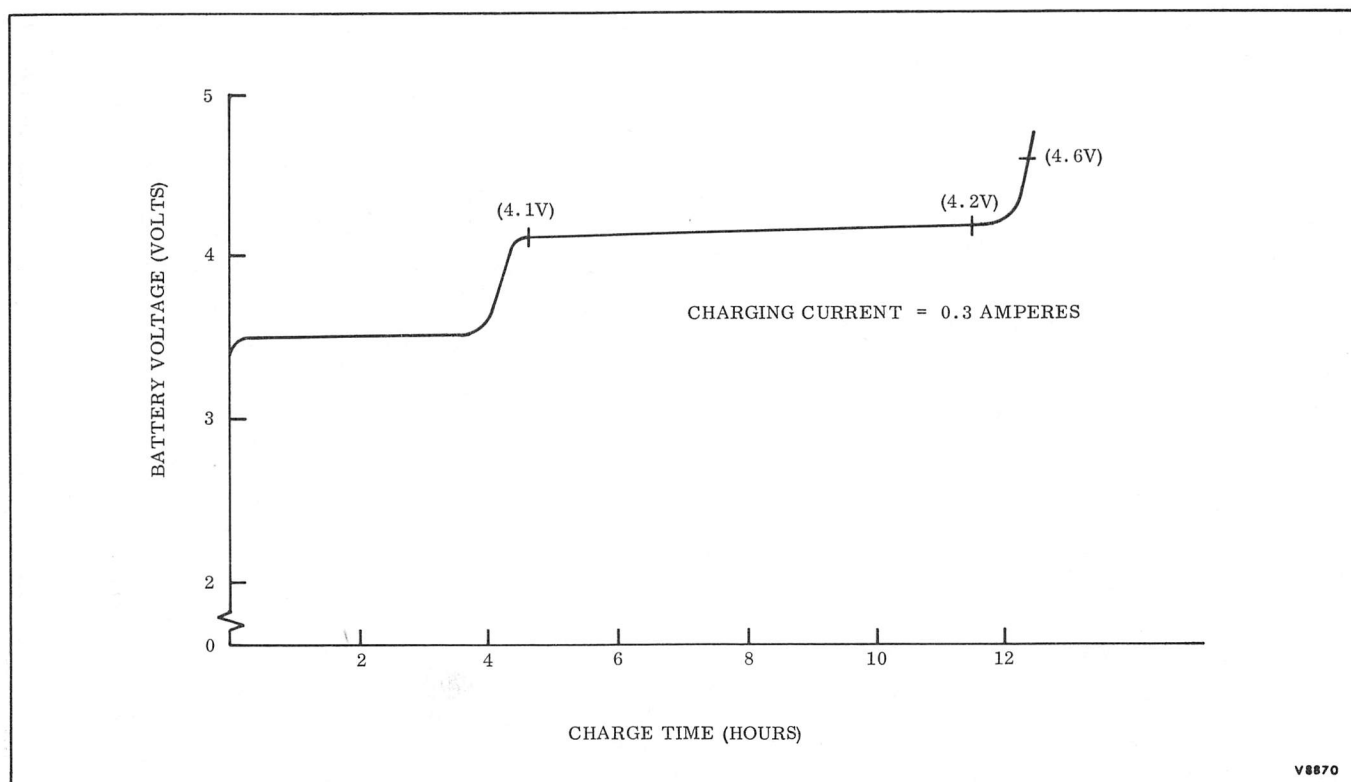


Figure 8-6. Battery Charging Curve

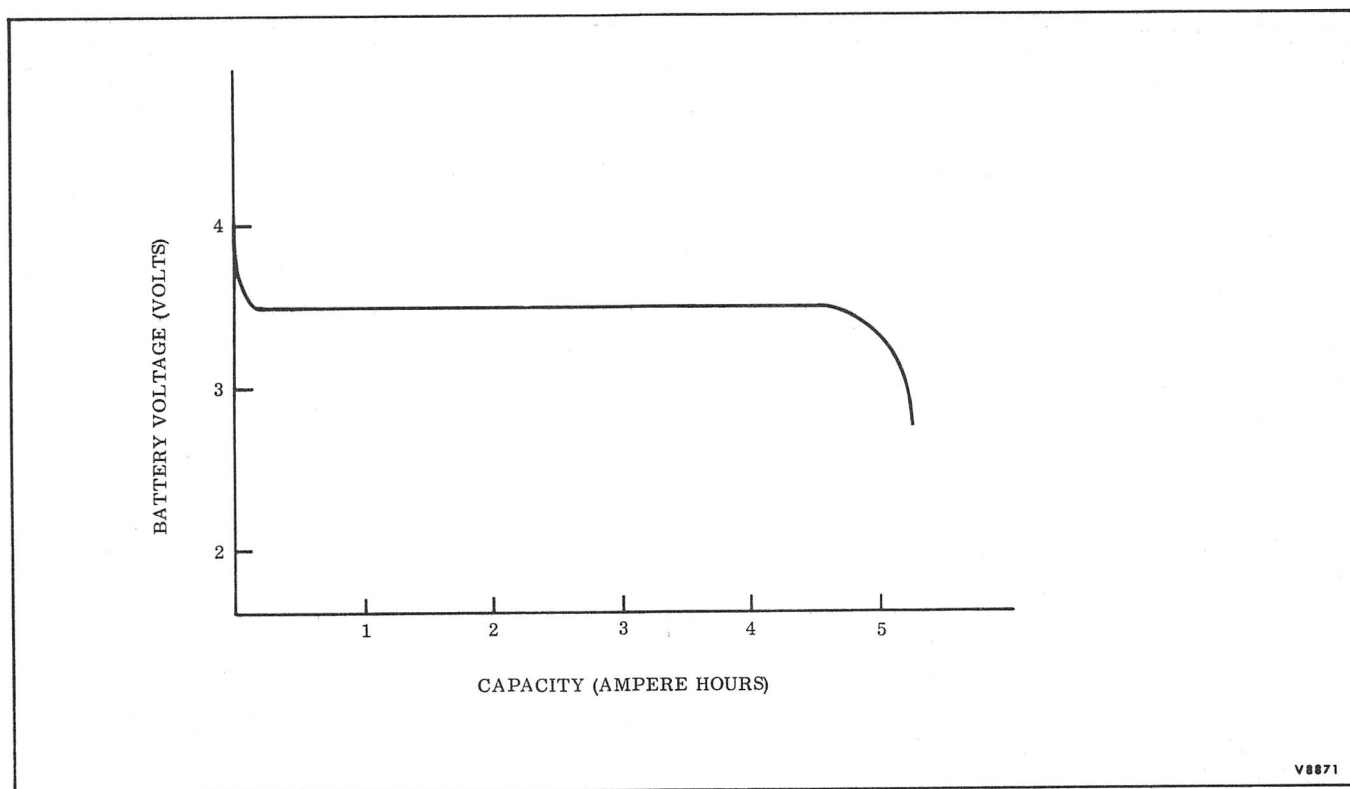


Figure 8-7. Battery Discharging Curve

case. This unit is useable in the field case or may be removed and used away from the case. Power input is 115/220 volt 50/60/400 Hz, available as European or North American standard commercial power, or special power. The battery charger is capable of charging two battery packs simultaneously. During the recharge cycle, each battery of the battery pack is charged individually. An indicator circuit to show full charge for each battery and an indicator to show if a battery is shorted, is included for each battery pack.

8-61 The battery charger is shown in block diagram, Figure 8-8 and in schematic, Figure 10-29. As mentioned above, the individual batteries of two battery packs (10 batteries for each pack) are charged individually with identical but unique charging circuits. The circuitry for each battery pack consists of 10 charging control circuits, divided so that five batteries are charged in the positive sense and the other

five are charged in the negative sense. Because of circuit duplication, only one charging control circuit is described below. The transformer-rectifier, voltage reference, and metering circuits are common to all the charging control circuits.

8-62 In operation, to charge one battery, a constant current is developed (0.3 ampere) and applied to the particular battery. Due to the interconnection at the battery connector, only one battery is connected into a charging circuit. The remaining batteries in the battery pack have individual charging circuits. A constant current is developed and defines terminal voltage (depending on the state of charge of the battery) which is measured by a voltmeter circuit to determine the state of the charge.

8-63 The output voltage from the respective voltage reference circuit is compared with the battery terminal voltage. At the instant when the battery voltage, with a

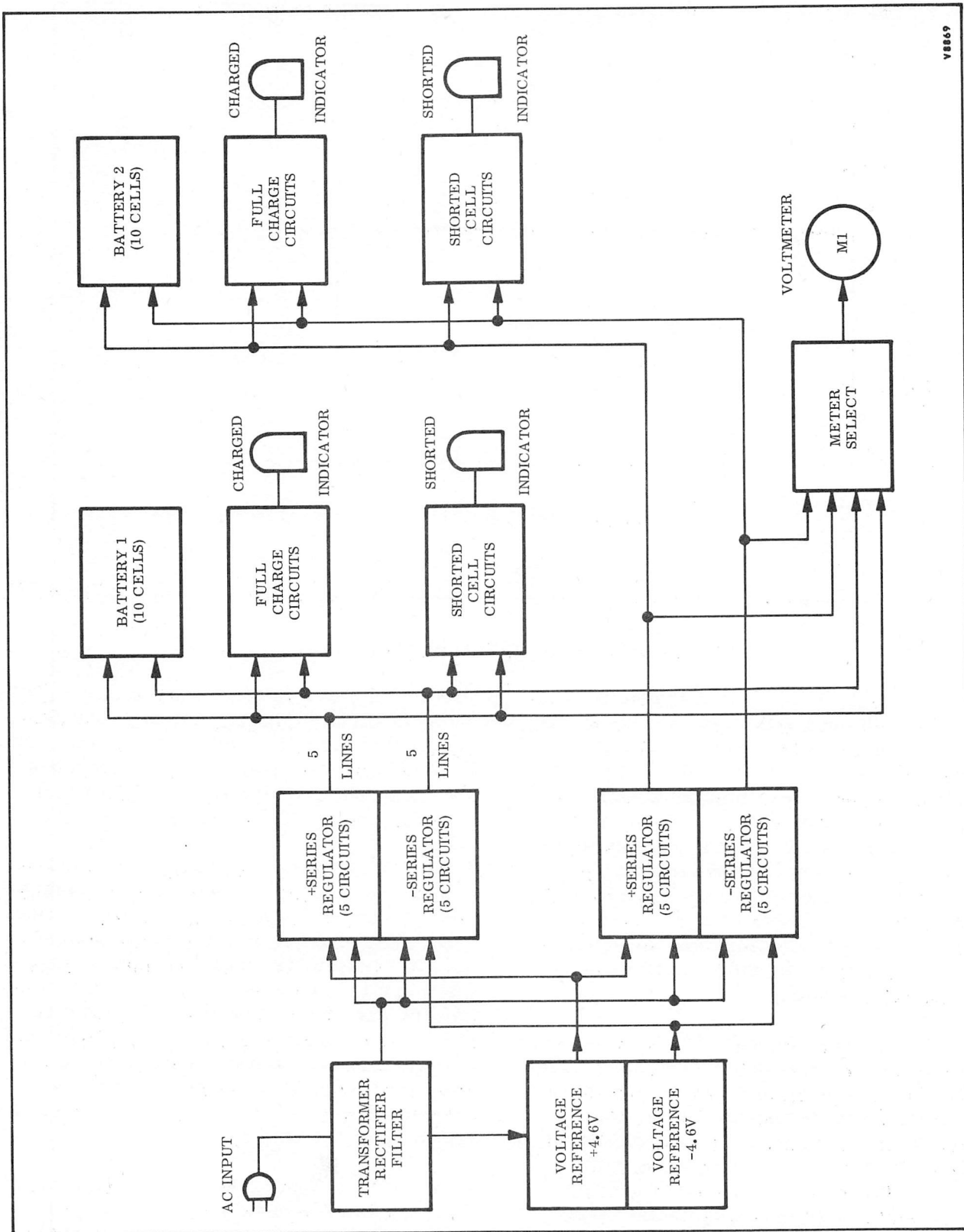


Figure 8-8. Battery Charger

constant current of 0.3 amperes, reaches 4.65 volts the control circuit shuts off the current and the battery stops charging. An indicator lamp is lighted to indicate the occurrence of the first fully charged battery. A circuit is also included, for each battery, to indicate an excessively low terminal voltage which indicates an internal short in the battery. When this condition is ascertained, the SHORT lamp is lighted.

8-64 Physically, the circuitry for the battery charger is located on six printed circuit boards. Board #1 and board #2 are identical and are interchangeable. Each of these two printed circuit boards contain the full-charge and shorted-cell determining circuitry for 10 batteries. Board #3 contains the circuitry for the two voltage references. Board #4 contains the constant current charging circuits for 20 batteries. Board #5 consists of the mating connector for the battery pack and the charging jumpers; board #5 is associated with battery pack #1 only. Board #6 performs the same function as board #5 except that it is associated with battery pack #2 only.

8-65 The power supply, metering circuit, and meter control circuits are situated on the chassis and are permanently wired into the charger.

8-66 POWER TRANSFORMER, RECTIFIER, AND FILTER

8-67 The power transformer T1 consists of a dual, multiple tapped primary winding and a center tapped secondary winding. This is shown in Figure 10-29. By interconnecting the primary windings in parallel, at the selected taps, the voltage input may be 105V, 115V, or 125V. By internally interconnecting the windings in series, between the selected taps and common, 210V, 230V, or 250V may be used as the input voltage. This feature is provided for low, normal and high line voltage conditions. The rectifiers consist of two full-wave circuits, providing positive and negative outputs. Filtering is provided by capacitors C1 and C2.

8-68 VOLTAGE REFERENCE CIRCUITS

8-69 Two voltage reference circuits are used to generate accurate +4.65 and -4.65 volt reference voltages. These voltages are used to compare against the charged battery terminal voltages to determine the fully charged condition. These circuits are located on board #3.

8-70 If either battery pack is plugged-in to the charger (BATT #1 or BATT #2) the positive voltage from the filter C1 is jumped-back to J4-A. Transistors Q1 and Q2 serve as a constant current source to provide operating current for voltage regulator diode VR1. This defines an exact voltage for use as a reference potential across potentiometer R1. The adjustment of R1 sets an input voltage for the operational amplifier at A1-3. Feedback around the operational amplifier to A1-2, adjusts the output voltage, so that the input voltage (feedback voltage) at A1-2 is equal to the voltage at A1-3. Thus, the output at A1-5 is a low impedance source for the positive reference voltage.

8-71 Similarly, the output at A2-5 is a negative reference voltage. The circuitry used to derive the negative reference voltage is similar to the positive reference circuitry except that the corresponding component is the complementary component of that used (replace PNP for NPN and vice-versa).

8-72 CHARGING CIRCUITS

8-73 Board #5 mates with the connector which is attached to the battery pack. The following description is concerned with the charging of cell #1. All other cells are charged simultaneously with similar, paralleled circuits. The reference voltage is brought to a differential comparator circuit Q2, through resistor R8 to the base. Transistor Q9 conducts when a battery is connected to the charger, and provides a ground return for the common emitter resistor of differential comparator Q2. As long as the reference voltage at R8 is greater than the battery voltage at R1, the collector of Q2 which is

associated with Q3, pulls the base of Q3 toward ground and causes Q3 to conduct. When Q3 conducts, operating current for the voltage regulator diode VR11 is provided and the base of Q1 on board #4 is held at the zener firing voltage of the diode. Transistor Q1 is a 0.3 ampere, constant current source of voltage for charging the battery.

8-74 When the battery voltage becomes greater than the reference voltage, as the battery is charged, the differential comparator switches so that the base of Q3 is released from ground potential and Q3 stops conducting. This stops the zener voltage at the base of Q1 on board #4, which in turn removes the charging current. Because the voltage will only rise above the reference voltage level when the battery is charged, the circuitry discussed has the function to turn off the charging current when the battery is charged. As mentioned previously, this is applicable for one battery only. The other batteries in the pack charge independently.

8-75 Diode CR15, CR16, and CR17 each define a voltage drop of approximately 0.6 volt; together with the voltage drop in the base-emitter junction of Q10 and the saturation voltage of Q9, a reference voltage is defined for use in the battery cell short circuit determining circuitry. This voltage is present at the anode side of diode CR2. If the battery voltage drops below this reference voltage, the diode is forward biased drawing current through R16. This causes the current through CR15, CR16, CR17, and the base-emitter junction of Q10 to decrease causing the voltage at Q10-collector to rise. As a consequence Q13 conducts and lights the SHORTED indicator.

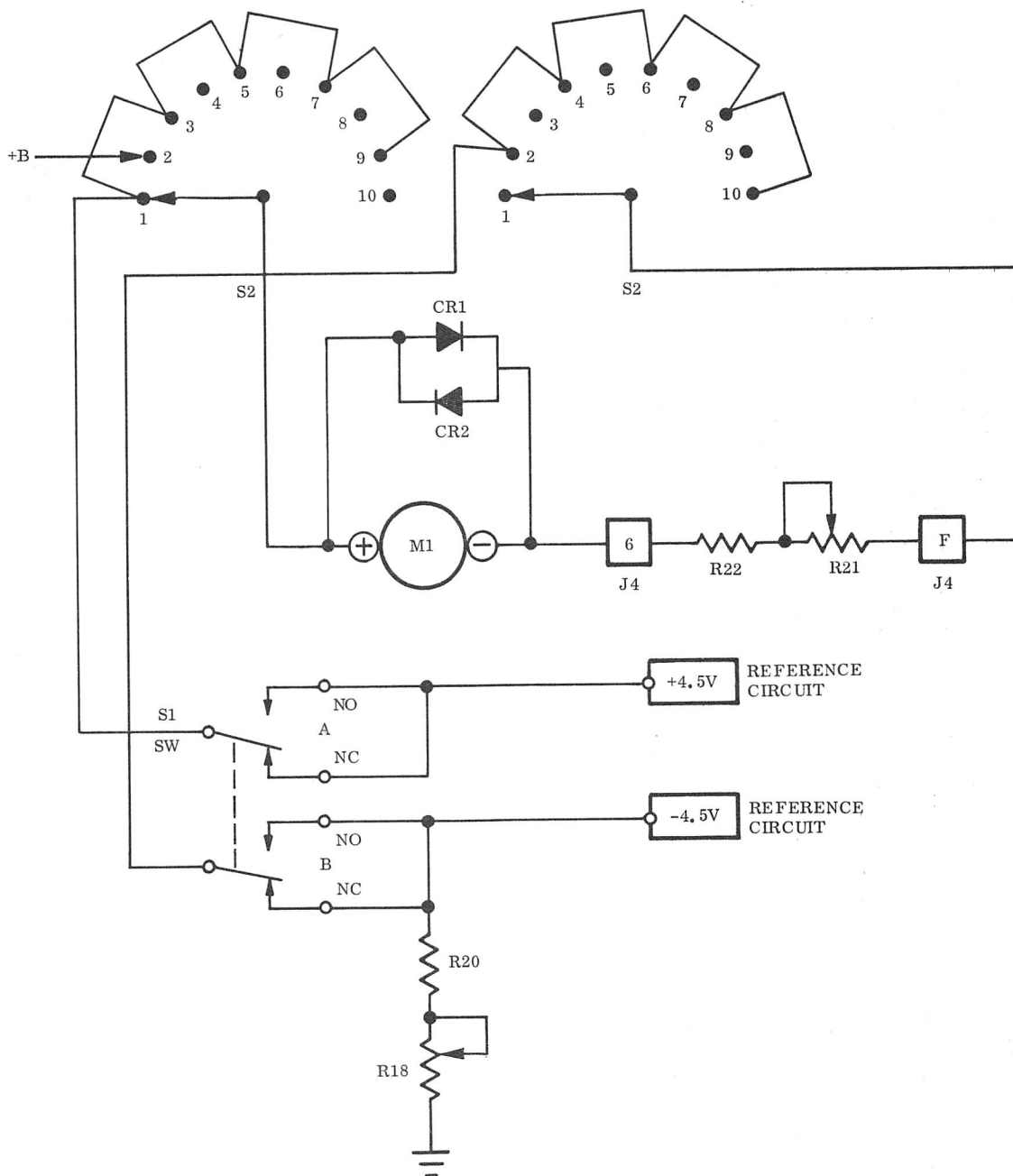
8-76 The CHARGED indicator lights when any battery is fully charged. This indicator lights when Q4 conducts, when the charging current is cut-off. If the battery voltage is greater than the reference voltage, the differential comparator switches and diode CR1 becomes forward biased, pulling the base of Q4 toward ground, causing Q4 to conduct.

8-77 The negative circuits of battery #1 and the circuits of battery #2 operate in the same manner as described above. Each provides a constant current control, charging shut-off control, shorted-cell determination, and charge-completed determination. The common circuits for each battery pack, are the short indicator, charge indicator, the positive and negative reference voltage circuits, and a metering circuit and Q9 turn-on transistor.

8-78 METERING CIRCUIT

8-79 The metering circuit consists of a two pole 10-position switch S2, connected to a dc voltmeter. Each position of the switch selects one set of batteries from one of the battery packs and indicates the cell terminal voltage on the meter. The meter circuit is equipped with an EXPANDED SCALE switch. Refer to Figure 8-9, for a simplified schematic of the metering circuit.

8-80 Switch S2 selects the battery voltage to be measured. Switch S1 is the EXPANDED SCALE switch. The current path, while reading the voltage of battery #1, cell #1, for example, is from the cell in question, through S2A-10 to S2A-SW, through the meter M1 (+ to -) to the meter sensitivity adjustment R22 and R21, to S2B-SW through S2B-10, to the EXPANDED SCALE switch S1B, through S1B-NC to R20 and R18, to ground. Resistor R21 serves as the expanded, scale sensitivity adjustment while R18 adjusts the normal scale voltage reading. When expanded scale readings are needed, switch S1 is operated. This removes the series resistances R20 and R18 to ground, and provides a return to either the +4.65 volt reference through R8, R9 or to the -4.65 volt reference through R17, R19. This has the effect of increasing the meter sensitivity and moving the zero deflection point of the meter to 4.50 volts. Therefore, the meter begins to read up-scale when the input voltage from the battery is 4.50 volts.



V8875

Figure 8-9. Voltmeter Circuit

SECTION IX

MAINTENANCE

9-1 INTRODUCTION

9-2 The purpose of this section is to aid the operator and repairman in keeping the VR-3000 VTR operating at peak efficiency. This section contains preventive maintenance and corrective maintenance procedures. The operator will be primarily responsible for performing preventive maintenance such as cleaning and inspecting the equipment, energizing and operating the equipment, and performing preoperational checks and adjustments to ensure proper operation. If the operator, while performing preventive maintenance, is given cause to suspect either the physical or electrical integrity of the VTR, the maintenance engineer should correct the fault and return the VTR to operation. The corrective maintenance procedures are to aid the maintenance man repair a faulty machine and make whatever adjustments necessary to return the machine to operation.

<u>Procedure</u>	<u>Paragraph Reference</u>
a. Operation	3-1
b. Heads and Tape Path Cleaning	9-9
c. Video Head Degaussing	9-13
d. Audio Head Degaussing	9-14
e. Battery Power Pack Recharge	9-15
f. Battery Power Pack Inspection and Cleaning	9-17
g. Power Pack Inspection	9-19
h. Cell Cleaning	9-20

9-3 TOOLS AND TEST EQUIPMENT

9-4 Table 9-1 lists the standard commercial tools and test equipment required for performance checkout and operation adjustment of the video tape recorder. The specific manufacturers and model numbers listed are only suggested items. Any equipment of at least equivalent capability may be used.

9-5 VARIABLE CONTROLS

9-6 The variable controls on the recorder main chassis and circuit boards are shown in Section XI, Illustrated Parts Breakdown. Table 9-2 lists the variable controls by board number, name, schematic reference number, function, and the Illustrated Parts Breakdown (IPB) figure number.

9-7 PREVENTIVE MAINTENANCE

9-8 The preventive maintenance procedures for the VR-3000 consists of the following:

Table 9-1. Commercial Tools and Test Equipment

EQUIPMENT TYPE	SUGGESTED MODEL
Oscilloscope	Tektronix 547
Oscilloscope Preamplifier	Tektronix 1A1
Oscilloscope Probe 10:1	Tektronix P-6000
Digital Voltmeter	Hickock DMS 3200
Video Monitor	Conrac CNA-8
Scale (0-2 lb.)	Ampex 650-105
Oscillator	HP200CD
VTVM	HP400D
AC Voltmeter	HP403B
Video Alignment Tape	Ampex 50262-07
Volt-ohmmeter (20,000 ohms/volt)	Triplett 620
Video Tape Recorder	VR-2000B
Tip Projection Gauge	Ampex 1218210-01
Video Noise Meter	Ampex 820
Hand-Held Degausser	Ampex 803
Headset	Telex HS-2000
Vacuum Gauge	

Table 9-2. Variable Controls

Board No.	Control Name	Schematic Reference	Function	Figure No.
FRONT PANEL				
Front Panel	Head Driver Voltage 1	R1	Adjusts video head #1 record current.	11-2
Front Panel	Head Driver Voltage 2	R2	Adjusts video head #2 record current.	11-2
Front Panel	Head Driver Voltage 3	R3	Adjusts video head #3 record current.	11-2
Front Panel	Head Driver Voltage 4	R4	Adjusts video head #4 record current.	11-2
Front Panel	Tracking	R5	Controls the head-to-track relative position. When the pointer matches the cursor, the heads traverse the home track.	11-2
Front Panel	Video Level	R6	Compensates for differences in input video levels.	11-2
±12 VOLT REGULATOR				
11	-12V Signal Adj	R1	Adjusts -12 Vdc signal circuits regulator output.	11-16
11	-12V SVO Adj	R26	Adjusts -12 Vdc servo circuits regulator output.	11-16
11	+12V SVO Adj	R33	Adjusts +12 Vdc servo circuits regulator output.	11-16
11	+12V Sig Adj	R56	Adjusts +12 Vdc signal circuits regulator output.	11-16
CAPSTAN SERVO				
13	Capstan Speed	R8	Adjusts speed of capstan to bring it within capture range of servo.	11-14

Table 9-2. Variable Controls (Cont.)

Board No.	Control Name	Schematic Reference	Function	Figure No.
CONTROL TRACK				
14	Rec C. T. Phase	R1	Adjusts ramp comparator threshold voltage to control pulse timing, and thereby the phase of the control track sine wave signal relative to the recorded video tracks.	11-13
14	Record C. T. Level	R2	Adjusts the record level of the control track signal.	11-13
14	Drum Timing Indicator	R3	Adjusts timing of a gate pulse used to sense condition of proper head drum phase position relative to vertical sync.	11-13
DRUM SERVO				
15	Drum Phase	R9	Adjusts phase of the drum with respect to a vertical sampling pulse.	11-12
15	Drum Speed Record	R8	Adjusts speed of head drum during record so as to place it within capture range of the servo circuit.	11-12
15	Drum Speed	R10	Adjusts free-running speed of head drum during playback.	11-12
MDA DRIVER				
16	0.5 Delay	R1	Adjusts timing of 6-tach pulses with respect to the once around pulse.	11-11
VIDEO INPUT AND OUTPUT				
18		R1	Adjusts video amplifier gain.	11-9

Table 9-2. Variable Controls (Cont.)

Board No.	Control Name	Schematic Reference	Function	Figure No.
AUDIO AGC AMPLIFIER				
24	±10V Adj	R1	Adjusts + and -10 volt outputs of the ±10 volt regulator by establishing an input level to operational amplifier A2.	11-19
24	Auto Gain Control Level	R10	Adjust threshold at which the audio AGC is brought into operation.	11-19
24	Bias No. 2	R38	Adjusts control voltage at which gain control #2 stage begins to operate.	11-19
24	Bias No. 1	R44	Adjusts control voltage at which gain control #1 stage begins to operate.	11-19
24	Gain Calibration	R52	Adjusts audio amplifier gain when AGC is disabled.	11-19
AUDIO HEAD DRIVE ASSEMBLY				
25	Bias Level	R1	Adjusts audio head bias current level.	11-3
25	Record Level	R4	Adjusts level of audio signal current in the audio head.	11-3
25	Record Eq. Adj	R6	Adjusts frequency response of the audio amplifier.	11-3
25	Playback Level	R7	Sets output level of audio output to the VTR headset jack.	11-3
3.6 VDC REGULATOR ASSEMBLY				
A3	3.6 VC Adj		Adjusts 3.6 Vdc Regulator output.	

Table 9-2. Variable Controls (Cont.)

Board No.	Control Name	Schematic Reference	Function	Figure No.
TAKEUP MOTOR DRIVER				
A2	Parking Torque	R28	Adjusts takeup motor torque in standby mode.	11-17
A2	Holdback Torque	R29	Adjusts takeup motor torque in rewind mode.	11-17
TAKEUP REEL COMPLIANCE ASSEMBLY, No. 1361731				
A7	Tension Adj	R1	Sets nominal value of takeup torque in play and record modes.	
SUPPLY REEL COMPLIANCE ASSEMBLY, No. 1361661				
A9	Tension Adj	R1	Sets nominal hold-back tension in play and record modes.	
MODULATOR/PREAMP ASSEMBLY				
21	Freq Adj	R90	Adjusts modulator frequency without affecting sensitivity.	11-22
21	Balance	R115	Adjusts modulator rf signal symmetry.	11-22
21	Deviation	R117	Adjusts modulator sensitivity (frequency vs. input voltage swing). Presence of dc on the input signal causes interaction between sensitivity and frequency controls.	11-22
SWITCHER/EQUALIZER				
22	RF Low-pass Filters	L9-L12	Adjusts low-pass filters response curve.	11-21
22	Switching Delay 2	R74	Adjusts switcher one-shot delay (430 microseconds).	11-21

Table 9-2. Variable Controls (Cont.)

Board No.	Control Name	Schematic Reference	Function	Figure No.
SWITCHER/EQUALIZER (Cont.)				
22	Switching Delay 1	R78	Adjusts switcher one-shot delay (80 microseconds)	11-21
22	RF Equalization	R79	Adjusts cosine filter response curve.	11-21
DEMODULATOR FILTER AMPLIFIER ASSEMBLY				
23		L2-L4 L6-L7	Adjusts video low-pass filter response curve and phase delay.	11-20
23		C34	Adjusts the balance of input signals to the demodulator.	11-20
23		R39	Adjusts switching bias for tunnel diode CR7.	11-20
23		R78	Adjusts output signal amplitude.	11-20
TACH TIME ERROR COMPENSATION ADJUSTMENTS ASSEMBLY, No. 1218234				
		R1-R5	Adjusts the individual 6-tach periods. Each potentiometer adjustments one period. Factory adjusted only!	
BATTERY CHARGER				
		R1	Adjusts meter sensitivity during normal indication.	11-25
		R10	Adjusts positive reference voltage.	11-25
		R18	Adjusts negative reference voltage.	11-25
		R21	Adjusts meter sensitivity during expanded scale and normal meter indication.	11-25

Table 9-2. Variable Controls (Cont.)

Board No.	Control Name	Schematic Reference	Function	Figure No.
AC POWER PACK (Battery Eliminator), No. 1385400				
		R4	Adjusts the dc balance of the shunt impedances.	11-28
		R20	Adjustable voltage sampling source for differential amplifier operation.	11-28

9-9 HEADS AND TAPE PATH CLEANING



EXERCISE EXTREME CARE TO AVOID SCRATCHING ANY OF THE TAPE CONTACTING SURFACES WHEN CLEANING COMPONENTS. OTHERWISE, SUBSEQUENT TAPE DAMAGE MAY OCCUR.

9-10 Residual magnetism of the heads along the tape path is a major source of second harmonic distortion and noise in the audio and video systems. An accumulation of foreign matter (e.g., tape oxide, dust, etc.) on the heads is a frequent cause for a loss of frequency response. For those reasons, it is recommended that all tape-contacting elements along the tape path be thoroughly cleaned, and that all rotary and stationary heads be demagnetized before using. The components of the tape transport should be cleaned at least every ten operating hours. An effective cleaning agent recommended for thorough cleaning of the tape path and removal of oxide and dust accumulations is Ampex Head Cleaner 087-007. Use a soft, lint-free cloth or chamois for cleaning surface areas such as the tape guides, tape tension arms, and capstan; a cotton swab (Q-tip, or equivalent) should be used

for cleaning smaller or less accessible surface areas such as the video heads, audio head, and vacuum tape guide. Moisten (do not saturate) the lint-free cloth, chamois, or cotton swab with the cleaning agent.

9-11 VIDEO AND AUDIO HEAD DEGAUSSING

9-12 The video and audio heads should be degaussed after every 6 hours of recorder operation to remove any residual magnetism. Need for degaussing the video heads will generally be indicated by either an inability to obtain optimum picture quality from the individual heads, or by low head output. A hand-held degausser such as the Ampex Model 820 should be used to demagnetize the video and audio heads. The procedures for degaussing the video and audio heads with the hand-held degausser are contained in the following paragraphs.



PERMANENT MAGNETS ARE CONTAINED WITHIN THE MARK XI VIDEO HEAD ASSEMBLY. NEVER USE A BULK-TYPE DEGAUSSER TO DEMAGNETIZE THE ASSEMBLY.

9-13 VIDEO HEAD DEGAUSSING. To degauss the video heads, proceed as follows:

- a. Remove any tape which may be threaded on the tape transport.
- b. Move the degausser to a point at least 6 feet from the recorder and connect the degausser to a 115 Vac power supply.
- c. Rotate the head drum (See Figure 4-4) until one of the video heads is accessible.
- d. Slowly move the degausser as close as possible to the video head, while taking care not to touch the video head tip with the pole tips of the degausser. (A piece of cellophane tape on the tips of the degausser will prevent metal-to-metal contact during the degaussing operation.)
- e. Straddle the gap in the video head tip with the pole tips of the degausser; after 3 to 4 seconds, move the degausser very slowly away from the head tip.
- f. While holding the degausser at arms length from the head tip, rotate the head drum until the next video head is accessible.
- g. Repeat steps d through f for the remaining video heads.
- h. When the demagnetization of the last head is completed, slowly move the degausser to a distance of at least 6 feet from the recorder; then disconnect the degausser from the ac power source.

9-14 AUDIO HEAD DEGAUSSING. To degauss the audio head, proceed as follows:

- a. Remove any tape which may be threaded on the tape transport.
- b. Move the degausser to a point at least 6 feet from the recorder and connect the degausser to a 115 Vac power source.

- c. Slowly move the degausser as close as possible to the audio head, while taking care not to touch the audio head with the pole tips of the degausser.

- d. Straddle the gap in the audio head with the pole tips of the degausser; run the tips very slowly up and down the entire length of the head gap for approximately 15 seconds.

- e. When the demagnetization of the audio head is completed, slowly move the degausser to a distance of at least 6 feet from the recorder; then disconnect the degausser from the ac power source.

9-15 BATTERY POWER PACK RECHARGE

9-16 To charge the battery power pack with the battery charger unit, proceed as follows:

- a. Connect the battery charger unit (Figure 11-25) to a power source (115V, 50, 60, or 400 Hz; or 220V, 50 or 60 Hz) with appropriate cable.
- b. Plug the battery power pack into the receptacle on either the right or left hand side of the battery charger unit. (Two power packs may be charged by the battery charger unit at the same time.)
- c. Place battery charger ON-OFF switch to ON and observe the SHORTED indicator lamp. If the lamp is lit, rotate CELL selector switch through positions 1 through 10 to determine which, if any, of the cells is shorted, as indicated by an excessively low dc indication on the meter. Replace any cell found to be shorted before proceeding with step d. (See paragraph 9-61.)

NOTE

The SHORTED indicator lamp on the battery charger unit lights when one or more of the power pack cells has excessively low terminal voltage.

d. Periodically, observe the CHARGED indicator lamp on the battery charger unit. When the CHARGED lamp lights, press the EXPANDED SCALE pushbutton and rotate the CELL selector switch through positions 1 through 10. The meter should indicate approximately 4.65 Vdc (the green line on the lower meter scale) for each position of the CELL switch. (When the EXPANDED SCALE pushbutton is pressed, the meter should indicate in the green area, 4.625 to 4.675 Vdc of the upper meter scale.) If not, continue charging the battery power pack until this result is obtained on all cells.

NOTE

The CHARGED indicator lamp on the battery charger unit lights when any one of the cells approaches full charge.

e. After determining that all the cells of the battery power pack are completely charged disconnect the power pack from the battery charger unit.

See paragraph 9-58 for additional information on the battery power pack.

9-17 BATTERY POWER PACK INSPECTION AND CLEANING

9-18 Once a month, remove the top of the battery power pack and inspect and clean the cells.

9-19 POWER PACK INSPECTION. Inspect the cells for loose terminals, remove electrolyte deposits (see paragraph 9-20), and replace the cell if the cell bulges or if dark spots are present on the terminals (see paragraph 9-61).

9-20 CELL CLEANING. It is normal in the life of the battery cells to breathe, and the breathing leaves deposits of potassium hydroxide electrolyte on the terminals. Use a mild solution of boric acid or acetic acid

(vinegar) as a cleansing agent and a cotton swab as an applicator to remove the electrolyte and clean the terminals. Wipe dry with a clean cotton cloth.

9-21 TROUBLE ANALYSIS

9-22 Trouble analysis should be initiated immediately if the video tape recorder is suspected of improper operation. Conduct a complete visual inspection before proceeding with more detailed trouble analysis. Check the VTR and all ancillary equipment to ensure that all cables and connectors are clean, securely and properly connected, and free of physical damage. Check for opened leads and burned components. Check that all switches and controls are properly set.



DO NOT REMOVE OR INSTALL ANY CIRCUIT BOARDS WHILE POWER IS APPLIED; THE RESULTING CURRENT SURGES CAN DESTROY SEMICONDUCTORS.

9-23 If no visible cause for failure can be found, it may be possible to isolate the trouble to a faulty system, board, or even to a stage by determining the exact malfunction symptom. Refer to the following sections on theory of operation:

<u>SECTION</u>	<u>TITLE</u>
IV	General Theory
V	Video Signal System Theory
VI	Servo System Theory
VII	Audio System Theory
VIII	Power Supply Theory

9-24 A malfunction of any component in the VR-3000 VTR may be located and repaired using normal troubleshooting techniques. Troubleshooting begins with a detailed isolation of the observed symptoms and evidence of malfunctioning. Refer to the applicable block diagrams, schematic diagrams, and waveforms in order to narrow the trouble to a specific area.

9-25 Having identified the trouble area, the successive steps toward localization of the trouble to a particular circuit requires examination of input and output signals, then point-to-point circuit checks for the first appearance of an abnormality. Occasionally, a thorough visual examination will reveal specific evidence of burning or charring of one or more components, thus pinpointing the trouble. Less frequently, internal trouble in a component may be detected by carefully listening for sounds of arcing or frying while the POWER switch is ON.

9-26 The point-to-point checks are performed using an oscilloscope and/or suitable meters for observations of waveforms, measurements of circuit and component resistances, and checks of capacitors.

9-27 Transistors may be tested either out-of-circuit or in-circuit (if the emitter and collector are temporarily disconnected from the circuit) with relative accuracy by the use of a VOM to measure forward and reverse bias resistance of both diode sections. Figure 9-1 A and C shows that a transistor is the equivalent of two diodes connected back-to-back. In an NPN transistor, the junction of the anodes forms the equivalent of the base terminal; in a PNP, the junction of the cathodes forms this equivalent. Thus, a connection of the negative VOM lead to the base of a PNP transistor, and the positive lead to the emitter or collector will forward bias the corresponding diode and register a low resistance, while reversing the leads will reverse the bias and register a much

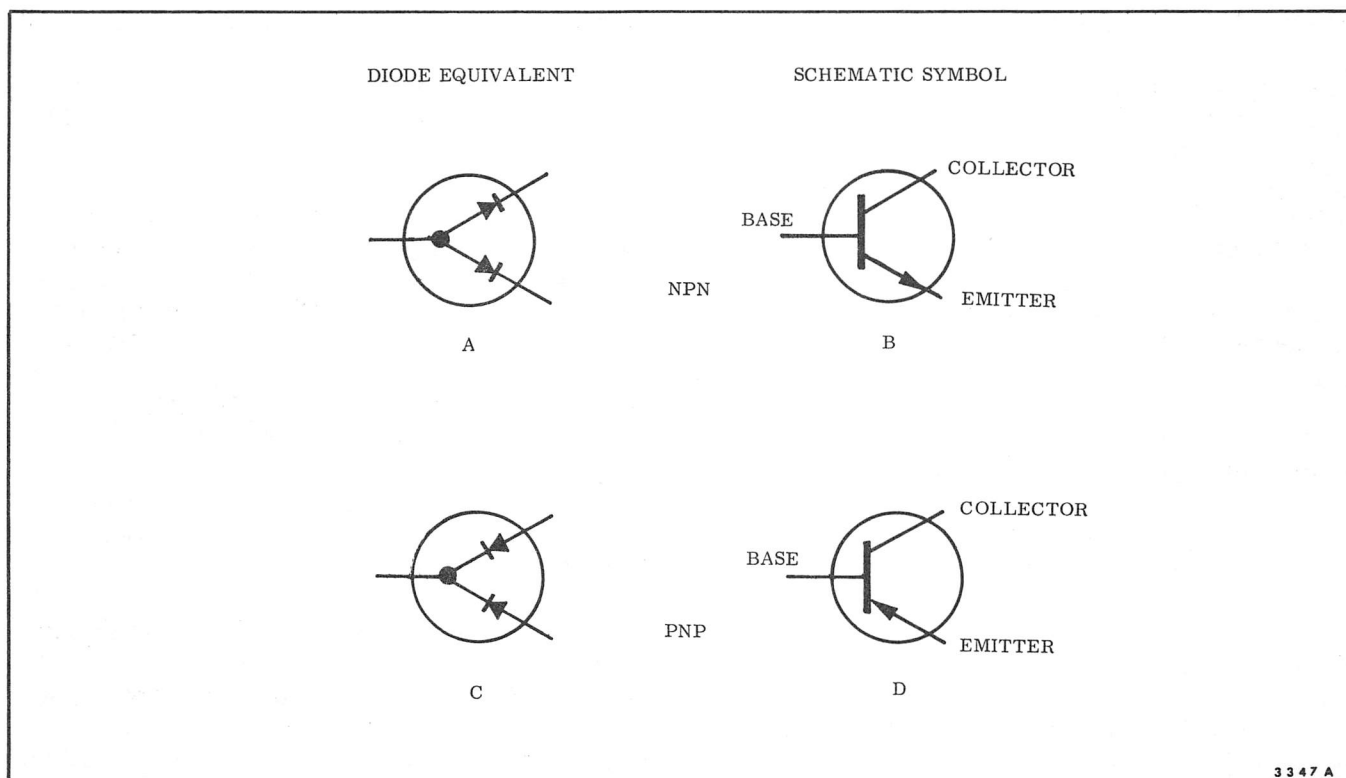


Figure 9-1. Transistor Symbols and Diode Equivalents

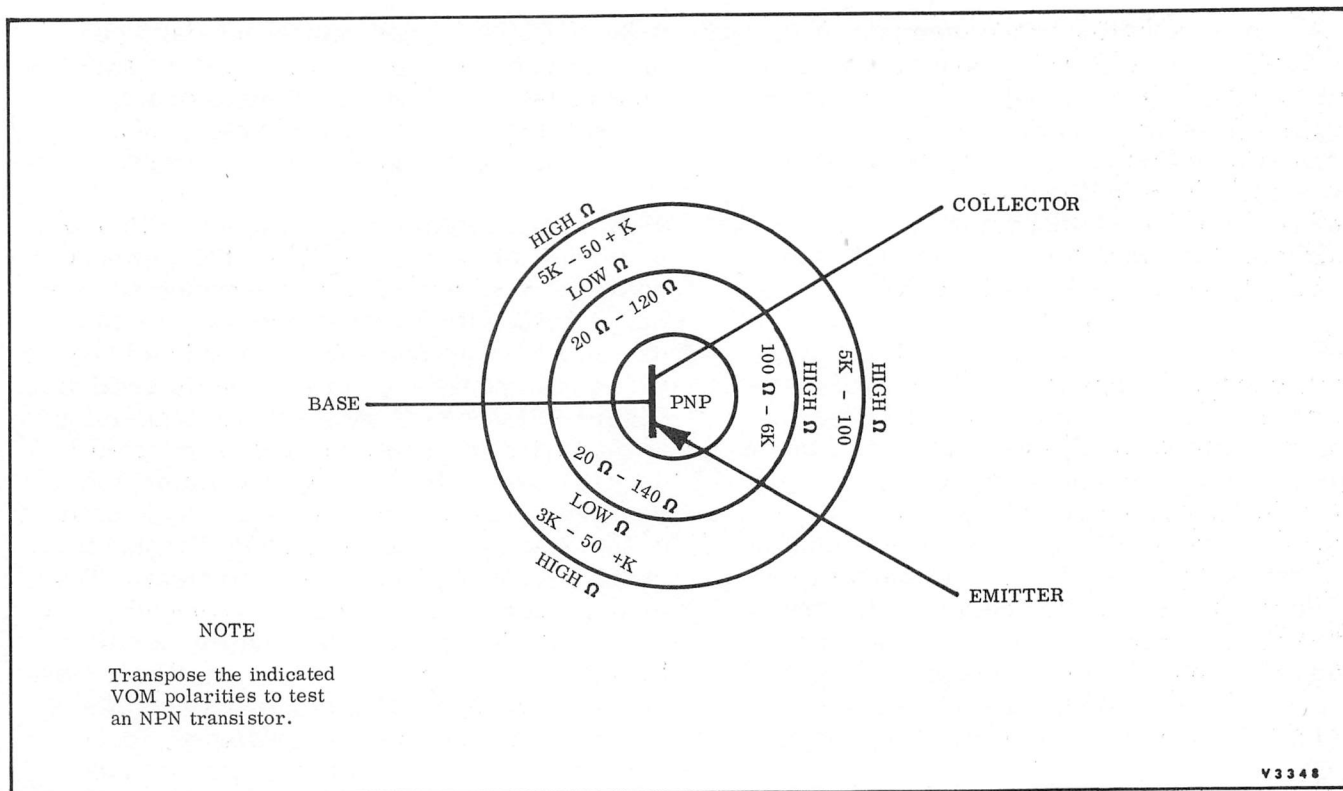


Figure 9-2. Normal Resistances Between Transistor Terminals

higher resistance (see Figure 9-2). The measurement of resistance between the collector and the emitter of a good transistor will indicate a high resistance using either polarity of the test leads, but one of the two measurements will be lower than the other.

9-28 There are several precautions to be observed during a VOM resistance test of a transistor, such as follows:

- a. Determine that operating power is disconnected from the circuit.
- b. The internal battery of the VOM should not exceed 3 volts.
- c. The true polarity of the VOM leads must be known.
- d. Use only the higher resistance scales of the VOM, in order to effectively limit the current flow caused by the internal battery.

e. Do not test high frequency transistors; their very small junction area may be damaged by the current flow.

f. Do not test certain diffused-base power transistors; their emitter-to-base breakdown voltage is very low under reverse bias. Consult the manufacturer's data for electrical characteristics of these types.

9-29 MARK XI VIDEO HEAD PREVENTIVE MAINTENANCE TIPS

9-30 The following are tips for getting maximum performance from the Mark XI Video Head:

- a. Before each day of use, closely inspect all metal surfaces (including tape guides, idlers, compliance arms, head tips, and drum) that touch the oxide-coated surface of the tape for an accumulation of oxide. If any oxide is present, remove it immediately, using a cotton-tipped swab, lint-free

cloth, or chamois moistened with head cleaner. Remember that degradation of the reproduced picture, caused by a buildup of oxide on the head tips, is usually accompanied by a buildup of oxide on the drum surfaces as well. Make it a practice to clean the head tips and the head drum periphery as soon as possible after such degradation first appears.

b. Be alert for sections of tape that are crumpled, creased, or scratched. These sections appear most often near the beginning of the tape; they must be removed before the tape is used, to avoid needless head-tip damage. Use care to avoid situations that may lead to tape creasing or crumpling.

c. Examine the head tips regularly by means of a tool-post-mounted microscope equipped with a diffused light source. The condition of the tapes being used may be determined by the appearance of the head

tips. If severe scratches are detected, polish the tips by running the head for a short period with tape that produces a polished condition. If any head tips are broken do not use the video head assembly until the tips have been repaired.

9-31 CORRECTIVE MAINTENANCE

9-32 To ensure optimum performance of the VR-3000 VTR the following adjustment procedures should be performed at frequent intervals and after repair and replacement of components. Figures 9-3, 9-4, and 9-5 show the location of printed circuit boards within the recorder. The boards are given the same numbers as the jacks to which they mate, i.e., board number 12 plugs into VR-3000 jack J12. See Section X for schematic diagrams and Section XI for parts location diagrams.

9-33 Corrective maintenance procedures for the VR-3000 consist of the following:

<u>Procedure</u>	<u>Paragraph</u>
a. Drum Servo Adjustment	9-34
b. Capstan Servo Adjustment	9-36
c. Control Track Adjustment	9-38
d. Playback Speed Adjustment	9-40
e. Video Head RF Drive Adjustment	9-42
f. Torque Adjustment	9-44
g. Tape Tension Adjustment	9-46
h. 3.6 Vdc Power Supply Adjustment	9-48
i. ± 12 Regulator Adjustment	9-50
j. Lubrication	9-52
k. Vacuum Adjustment	9-54
l. AC Power Pack (Battery Eliminator)	9-56
m. Battery Power Pack	9-58
n. Battery Power Pack Cell Replacement	9-61
o. Vacuum Tape Guide Standard Position Check	9-63
p. Video Head Transformer Adjustment	9-65
q. Tip Projection Measurement	9-67

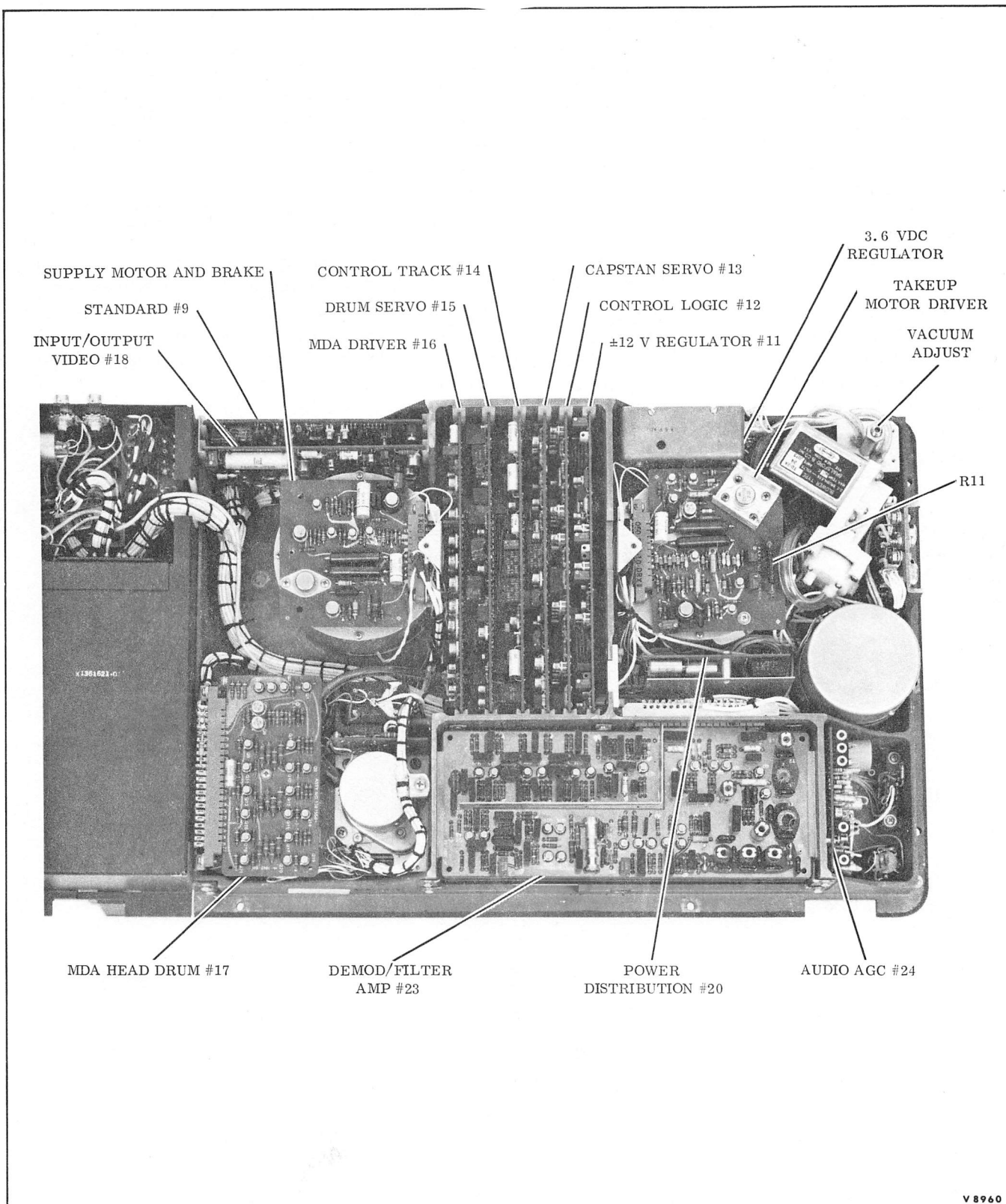


Figure 9-3. VR-3000 Bottom View

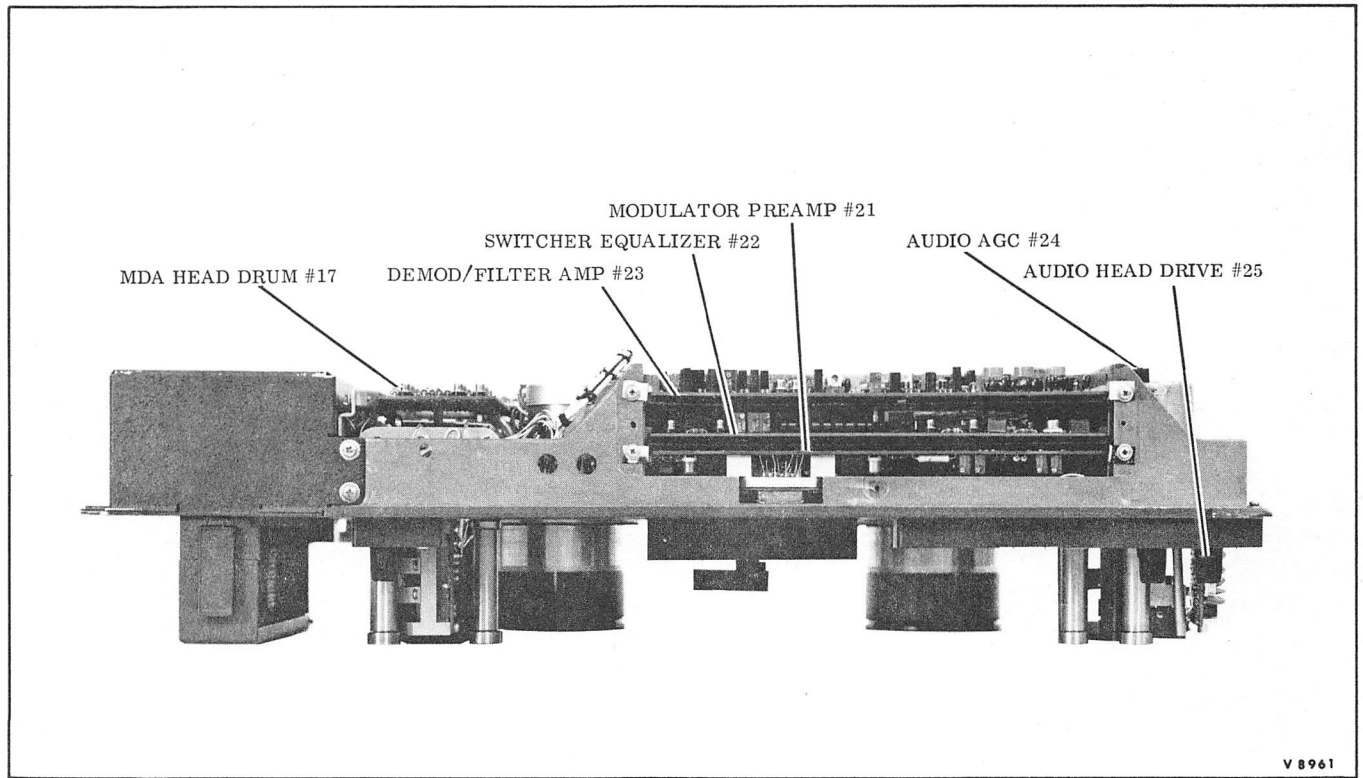


Figure 9-4. VR-3000 Near Side View

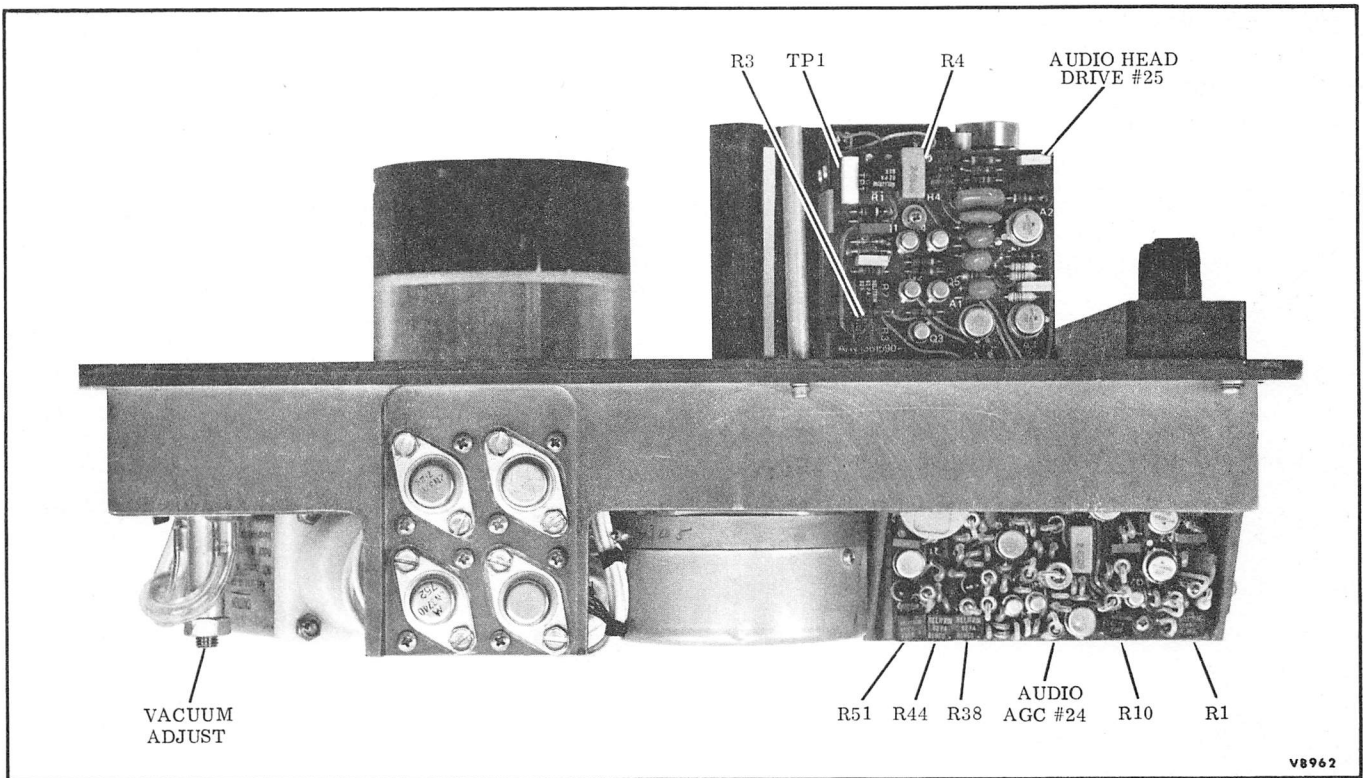


Figure 9-5. VR-3000 Left Side View

9-34 DRUM SERVO ADJUSTMENT

9-35 The drum servo adjustment procedure should be performed only after one of the following occurs: when changing between a 50 fps and 60 fps standard; when a defective component has been replaced in the drum servo; or when operational difficulties indicate a need for readjustment. Avoid unnecessary adjustment of the drum servo. To perform the drum servo adjustment proceed as follows:

a. Remove the name plate between the supply and takeup reels on top of the tape transport, and remove the recorder from its carrying case to gain access to the Drum Servo board 15 (see Figures 10-22 and 11-12).

b. Connect a 525/30 or 625/25 standard test signal to VIDEO IN bnc jack J7 on the side of the recorder.

c. Connect an oscilloscope to 6 TACH test point TP10 on the front panel Test Point Panel (TPP). Press RECORD READY pushbutton. Set the oscilloscope sweep rate to 1 msec/division, and trigger oscilloscope with positive edge of the vertical pulse at the V. PULSE test point TP14.

d. Observe the oscilloscope waveform. If waveform is not stationary, perform steps e through g and repeat steps c and d. If waveform is stationary, proceed to step h.

e. With no tape loaded on the tape transport, press PLAY pushbutton.

f. Set oscilloscope sweep rate to 100 microseconds/division. With oscilloscope still connected to 6 TACH test point TP10, trigger oscilloscope with negative edge of the 6-tach signal at the 6 TACH test point (internal).

g. Adjust Drum Record Speed potentiometer R8 on Drum Servo board 15 until the period of the signal observed on the oscilloscope is 694 microseconds for 60 fields-per-second (fps) systems or 666 microseconds for 50 fps systems. After R8 is properly adjusted, press the STOP pushbutton.

h. Disconnect oscilloscope and connect a VTVM to the DRUM ERROR test point TP12. Adjust Drum Record Speed potentiometer R8 for 3.0 (± 0.1) volts.

NOTE

In order to ensure proper adjustment of Drum Phase Potentiometer R9 in step k, the oscilloscope sweep rate should be set to exactly 10 microseconds/division, as outlined in step i.

i. Set oscilloscope sweep rate to exactly 10 microseconds/division as follows:

1. Turn oscilloscope X5 sweep magnifier to ON.

2. Connect oscilloscope to VIDEO IN test point TP8. Trigger oscilloscope with positive edge of the vertical pulse at the V. PULSE test point TP14.

3. Adjust oscilloscope variable sweep rate until one horizontal interval occupies 6.35 divisions for the 525-line standard (6.40 divisions for the 625-line standard).

4. Adjust oscilloscope horizontal positioning until leading edge of the fourth equalizing pulse in the last group of equalizing pulses for the 525-line standard (the last equalizing pulse for the 625-line standard) is centered.

j. Connect oscilloscope to V. PULSE test point TP14. Trigger oscilloscope with negative edge of the once-around tach signal at the 1/A ROUND test point TP9. (Do not readjust oscilloscope sweep rate after it has been set to exactly 10 microseconds/division in step i.)

k. Adjust Drum Phase Potentiometer R9 until positive edge of the vertical pulse is 0.60 divisions to left of center for the 525-line standard (2.1 divisions to left of center for the 625-line standard).

NOTE

Proper adjustment of Drum Phase potentiometer R9 results in the negative trailing edge of the once-around tach signal occurring exactly 252 microseconds before the positive leading edge of the vertical pulse for 60 fps system (239 microseconds for 50 fps systems).

l. Press STOP pushbutton and remove test equipment from recorder.

m. Press RECORD READY and PLAY pushbuttons. Observe that the SERVO LOCK indicator lamp DS1 lights. If indicator lamp is not lit, or if significant adjustment was required to perform step k, perform steps n and o.

n. Connect a standard composite video signal to VIDEO IN jack J7. Adjust Lock Detector potentiometer R3 on Control Track board 14 (see Figures 10-23 and 11-13) until SERVO LOCK lamp lights.

o. Determine range of settings of Drum Timing Indicator potentiometer R3 (by counting number of turns) which cause the SERVO LOCK lamp to light. Readjust R3 to the center of this range.

p. Press STOP pushbutton and return equipment to original configuration.

9-36 CAPSTAN SERVO ADJUSTMENT

9-37 The capstan servo adjustment procedure should be performed only after one of the following occurs: when changing between a 60 fps and 50 fps standard, when a defective component has been replaced in the capstan servo, or when operational difficulties indicate a need for readjustment. Avoid unnecessary adjustment of the capstan servo. To perform the capstan servo adjustment proceed as follows:

a. Remove name plate between the supply and takeup reels on top of the tape transport, to gain access to the adjustments on Capstan Servo board 13 (see Figures 10-25 and 11-14).

b. Press RECORD READY and PLAY pushbuttons.

NOTE

If a dual-trace oscilloscope is used, perform steps c through h. If not, perform steps i through j.

c. Connect Channel A of the oscilloscope to the 6 TACH test point TP10. Trigger oscilloscope with positive edge of this signal.

d. Connect Channel B of the oscilloscope to the CAP TACH test point TP15. Display the two traces in the "chopped" mode of the dual-trace oscilloscope.

e. Set oscilloscope sweep rate to 100 msec/division. Adjust triggering level as required.

f. Adjust Capstan Speed potentiometer R8 on Capstan Servo board 13 until 6 full cycles of the CAP TACH signal are included within that area occupied on the screen by a full cycle of the TACH signal. The R8 adjustment must be carefully made to avoid spurious frequency ratios which appear to be stable.

g. Check relative positions of the positive edge of the 6 TACH signal and negative edge of the CAP TACH signal. The positions should be the same for both of the 6 TACH pulses.

h. Set oscilloscope sweep rate to 0.5 msec/division. Verify that the time relationship established in step g holds for each of the several 6 TACH pulses now displayed. Proceed to step k.

i. If a single-trace oscilloscope is used, the 6 TACH and CAP TACH signals will have to be displayed alternately. Mark the position of the positive edge of the 6 TACH signal on the oscilloscope graticule (use a grease pencil or other suitable means), then display the CAP TACH signal.

j. Perform steps c through h using the techniques of step i.

k. Stop capstan rotation by manually holding the capstan. Release the capstan and verify that the ratio of frequencies remains the same.

l. Disconnect oscilloscope and connect VTVM to the CAP ERROR test point TP13. Adjust Capstan Speed potentiometer R8 on Capstan Servo board 13 for zero Vdc.

m. Adjust Capstan Speed potentiometer R8 for 6 full cycles of the CAP TACH signal within that area occupied by a full cycle of the TACH signal.

NOTE

The R8 adjustment must be carefully made to avoid spurious frequency ratios which appear to be stable.

n. Connect VTVM to CAP MOTOR test point TP16. The VTVM should indicate approximately -4V. Record exact level for future reference: _____ Vdc.

o. Press STOP pushbutton and return equipment to original configuration.

9-38 CONTROL TRACK ADJUSTMENT

9-39 The control track adjustment procedure should be performed whenever the Mark XI Video Head Assembly is changed in the recorder. To perform the control track adjustment proceed as follows:

a. Remove the name plate between the supply and takeup reels on top of the

tape transport to gain access to the adjustment on Control Track board 14 (see Figures 10-23 and 11-13).

b. Load a bulk-degaussed tape on tape transport.

c. Press RECORD READY and PLAY pushbuttons.

d. Connect oscilloscope to CT REC test point TP17.

e. Connect a microphone to AUDIO IN jack J2. Adjust Control Track Record Level potentiometer R2 on Control Track board 14 throughout its range, while announcing the amplitude of the oscilloscope display for each setting of R2.

f. Press STOP pushbutton; then press REWIND pushbutton to rewind the tape.

g. Connect oscilloscope to CT PB test point TP20. Press PLAY pushbutton.

h. While observing oscilloscope, determine which record amplitude produces a slight inflection in the region of the zero crossover of the control track playback signal. (See Figure 9-6.)

NOTE

Occurrence of an inflection indicates that the record current level has reached the "saturation knee" of the tape magnetization characteristics.

i. Press STOP pushbutton and connect oscilloscope to the CT REC test point TP17.

j. Press RECORD READY and PLAY pushbuttons. Adjust Control Track Record level potentiometer R2 until observed waveform amplitude is equal to that which produced the inflection in step h.

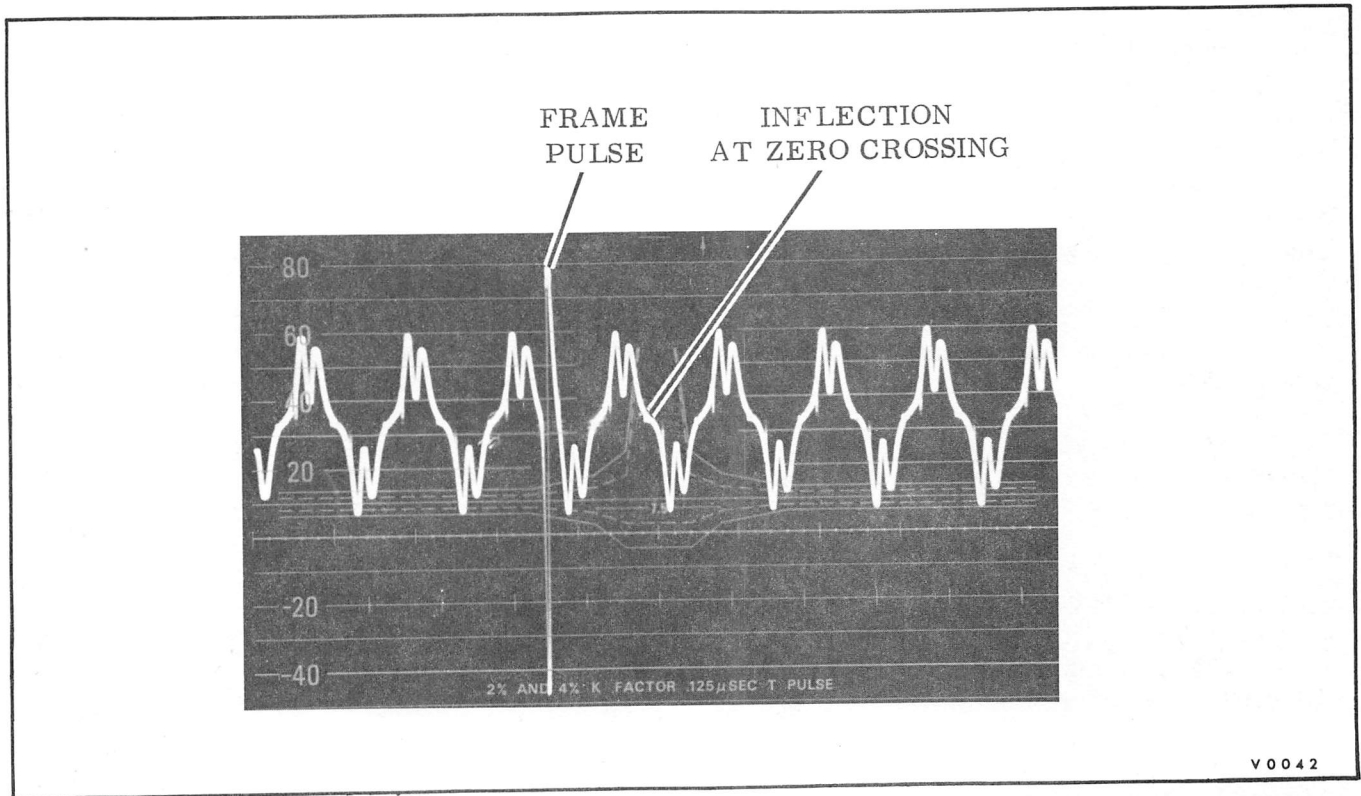


Figure 9-6. Control Track Waveform

k. Connect oscilloscope to the CT REC test point. Adjust Control Track Phase potentiometer R1 on board 14 until the negative frame pulse appears at the peak of a positive alternation of the control track signal.

l. Press STOP pushbutton, remove test equipment, replace nameplate, and return equipment to original configuration.

9-40 PLAYBACK SPEED ADJUSTMENT

9-41 The playback speed adjustment procedure should be performed whenever it is necessary to have the rate of playback video exactly equal to the rate of recorded video. To perform the playback speed adjustment procedure proceed as follows:

a. Remove the nameplate between the supply and takeup reels on top of the tape transport, to gain access to Drum Playback

Speed potentiometer R8 on Drum Servo board 15 (see Figure 10-22 and 11-12).

b. Load a previously recorded tape onto the tape transport.

c. Press RECORD READY and PLAY pushbutton.

d. Connect oscilloscope to VIDEO MONITOR jack J3 on side of recorder. Trigger oscilloscope with the appropriate vertical sweep reference signal (i.e., power line or station vertical drive signal).

e. Adjust Drum Playback Speed potentiometer R8 for a stationary display on oscilloscope. If unable to reach an adjustment, repeat Drum Servo Adjustment (see paragraph 9-33).

f. Press STOP pushbutton, remove test equipment from recorder, and return equipment to original configuration.

9-42 VIDEO HEAD RF DRIVE
ADJUSTMENT

9-43 The video head rf drive adjustment procedure should be performed after every 25 hours of video head use. To perform the video head rf drive adjustment proceed as follows:

a. Load a bulk-degaussed tape on the tape transport.

b. Connect a microphone to the AUDIO IN jack J2 on the recorder. Press RECORD READY and PLAY pushbuttons.

c. Set VTVM to 25V scale (or greater). Connect VTVM between the -12V test point TP5 (negative) and HEAD DRIVER VOLTAGE -1 (positive) test point TP1 above the control pushbuttons.

d. Adjust HEAD DRIVER VOLTAGE -1 potentiometer throughout its range, while announcing the voltage indication on the VTVM for each setting of the potentiometer.

e. Using the HEAD DRIVER VOLTAGE -2, -3, and -4 test points and potentiometers, repeat steps c and d for video heads 2, 3, and 4, respectively.

f. Press STOP pushbutton; then press REWIND pushbutton to rewind the tape.

g. Connect oscilloscope to the RF ENV test point TP11. Set oscilloscope sweep rate to 1 msec/division. Trigger oscilloscope with the once-around tach signal at the 1/A ROUND test point TP9.

h. Press the PLAY pushbutton. For each video head, determine the head driver voltage level beyond which no further increase in amplitude of the displayed rf envelope is possible. Record each of these voltage levels:

Head - 1 _____ V

Head - 2 _____ V

Head - 3 _____ V

Head - 4 _____ V

i. Repeat step c. Place recorder in record mode, and set the HEAD DRIVER-1 potentiometer for the VTVM indication recorded in step h.

j. Repeat step i for the remaining head driver potentiometers.

9-44 TORQUE ADJUSTMENT

9-45 To adjust the tape transport parking torque and holdback torque proceed as follows:

a. Set VTVM to 30 Vdc scale (or greater).

b. Connect VTVM between test points TP1 and TP2 (across 5 ohm resistor R11 on Takeup Motor Driver board (see Figures 10-19 and 11-17).

c. Set recorder POWER switch to ON.

d. Press RECORD READY and PLAY pushbuttons.

e. While holding the takeup motor, adjust PARKING TORQUE potentiometer R12 for 0.25 Vdc on VTVM.

f. While holding the takeup motor and pressing the REWIND pushbutton, adjust HOLDBACK TORQUE potentiometer R20 for 0.85 Vdc on VTVM.

g. Press STOP pushbutton, remove test equipment, and return equipment to original configuration.

9-46 TAPE TENSION ADJUSTMENT

9-47 To adjust the amount of tension placed on the tape proceed as follows:

a. Wrap 15" of tape from supply reel around idler posts and supply tension

spring. Fasten a scale to tape 4" from idler post, and hold as close as possible to normal tape path.

b. Hold tape to supply hub and keep tape and reel from moving.

c. Pull scale for 8 ounces of tape tension.

d. On the chassis, mark location of tension spring with 8 ounces of tension applied.

e. Set recorder POWER switch to ON and press the RECORD READY and PLAY pushbuttons.

f. Connect VTVM to CAPSTAN motor test point TP16. Press RECORD and PLAY pushbuttons. Read and record VTVM reading (approximately -4 Vdc):

_____ Vdc

g. Press STOP pushbutton.

h. Place full reel of tape on the transport.

i. Set Supply Tension potentiometer R1 and Takeup Tension potentiometer R1 to mid-range.

j. Set recorder POWER switch to ON and press the RECORD READY and PLAY pushbuttons.

k. Adjust Supply Tension potentiometer until the tension spring aligns with the 8 ounce mark made in step d.

l. Adjust Takeup Tension potentiometer R1 for same voltage obtained in step f.

m. Set POWER switch to OFF, disconnect test equipment, and return equipment to original configuration.

9-48 3.6 VDC POWER SUPPLY ADJUSTMENT

9-49 The 3.6 Vdc power supply furnishes power to all the VR-3000 integrated circuits. To adjust the 3.6 Vdc power supply proceed as follows:

a. Press RECORD READY and PLAY pushbuttons.

b. Set VTVM to 30V (or greater) scale. Verify that the +12 and -12Vdc inputs are within $\pm 0.1\%$. Troubleshoot and/or adjust the ± 12 Vdc regulators as necessary (see paragraph 9-50).

c. Connect VTVM to the 3.6 V output (see Figure 10-1).

d. Adjust 3.6 V ADJ potentiometer R10 for 3.6 Vdc.

e. Remove VTVM.

f. Press STOP pushbutton.

9-50 ± 12 V REGULATOR ADJUSTMENT

9-51 The ± 12 Vdc Regulator supplies regulated positive and negative 12 volts to the VR-3000 signal and servo circuits. To adjust the regulator proceed as follows:

a. Press RECORD READY and PLAY pushbuttons.

b. Set digital voltmeter to 30V (or greater) scale. Verify that the B+ and B- voltages at test points TP6 and TP7 are +15 volts ± 2 volts.

c. On the ± 12 V Regulator board 11 (see Figures 10-17 and 11-16) connect voltmeter between -12V SIG test point TP1 and GROUND test point TP18.

d. Adjust -12V SIGNAL ADJ potentiometer R1 for -12 volts.

e. Connect voltmeter to -12V SVO test point TP2.

f. Adjust -12V SVO ADJ potentiometer R26 for -12 volts.

g. Connect voltmeter to +12V SVO test point TP3.

h. Adjust +12V SVO ADJ potentiometer R33 for +12 volts.

i. Connect voltmeter to 12V SIGNAL test point TP4.

j. Adjust +12V SIG ADJ potentiometer R54 for +12 volts.

k. Disconnect voltmeter.

l. Press STOP pushbutton.

9-52 LUBRICATION

9-53 Permanently lubricated bearings are used throughout the VR-3000. Lubrication instructions are therefore not included in this manual.

9-54 VACUUM ADJUSTMENT

9-55 The vacuum system seldom requires any maintenance other than to occasionally clean the vacuum lines. The vacuum pressure is set at the factory and should remain at that setting, but if repair and replacement is required to maintain the vacuum system then the pressure should be checked and set as necessary. To adjust the vacuum proceed as follows:



TO OPEN (OR CLOSE) THE VACUUM TAPE GUIDE, EASE THE GUIDE INTO THE FULLY OPEN (OR FULLY CLOSED) POSITION. OPEN AND CLOSE THE TAPE GUIDE GENTLY

TO AVOID CAUSING A MISALIGNMENT OF THE MECHANISM AT EITHER LIMIT OF TRAVEL.

a. Disconnect the vacuum hose where it enters the Mark XI Video Head tape guide (see Figure 4-4).

b. Connect a vacuum gauge to the vacuum hose.

c. Set the recorder POWER switch to ON and press the RECORD READY pushbutton. The vacuum gauge should read 40 inches of water; if not, proceed to step d.

d. Loosen the locking nut on the vacuum adjustment.

e. With an Allen-wrench, adjust the vacuum adjustment for 40 inches of water.

f. Tighten the locking nut.

g. Verify the setting remains accurate.

h. Remove vacuum gauge and reconnect vacuum hose to tape guide.

9-56 AC POWER PACK ADJUSTMENT

9-57 The ac power pack (battery eliminator) changes 115V, 50, 60 or 400 Hz and 220V, 50 or 60 Hz line voltage to positive and negative 15 Vdc thus dispensing with the need of a charged battery power pack whenever ac power is available. To adjust the ac power pack proceed as follows:

a. Mount ac power pack in recorder.

b. Connect power cable (Ampex part number 1363360 for 115V, 50, 60 or 400 Hz; and Ampex part number 1361361 for 220V, 50 or 60 Hz) between the ac power pack jack J1 and the ac power source.

c. Set ac power pack circuit breaker, CB1, and power switch, S1, to ON positions.

d. Set recorder POWER switch to ON and push the RECORD READY and PLAY pushbuttons.

e. Set the VTVM to 40 Vdc (or greater) scale.

f. Connect VTVM between pins L and 2 of the ac power pack output jack J2 (see Figure 10-30).

g. Adjust potentiometer R20 for 30 Vdc.

h. Adjust potentiometer R4 so that the +15 Vdc measured between J2-L and J2-C is of equal magnitude to the -15 Vdc measured between J2-2 and J2-C.

i. Disconnect VTVM.

j. Press STOP pushbutton.

9-58 BATTERY POWER PACK

9-59 The silver cadmium battery power pack has ample capacity (even when old) to power all the operations leading to the recording and review of a 20-minute tape. However, since there is no reliable method for determining the state-of-charge of the power pack, it is recommended that the power pack be removed from the VR-3000 and recharged after recording a full reel of tape on the recorder. During the recharging operation, each of the ten cells of the power pack is completely charged to 4.65 volts dc. The power pack takes from 10 to 12 hours to completely charge from the fully discharged state.

CAUTION

WHEN THE BATTERY POWER PACK IS NOT BEING USED, AVOID EXPOSING IT TO TEMPERATURES OVER 110°F (43.3°C) FOR LONGER THAN 4 HOURS DAILY OR 120 HOURS TOTAL.

OTHERWISE THE LIFE OF THE BATTERY POWER PACK WILL BE SIGNIFICANTLY REDUCED.

9-60 Partial loss of voltage and capacity will result if the battery power pack is not used for periods longer than 3 months. Such losses can be reduced by either regular use of the power pack (i.e., at least one charge-discharge cycle every 90 days) or by storing the power pack, in either the charged or discharged condition, at the low temperature range of 0 to 45°F (-17.6 to 4.4°C). The discharged condition of the power pack is considered to be obtained when positive and negative 13.5 volts or lower are present at the B+ and B- test points, TP6 and TP7, with a 2-ampere load. A 2-ampere load is provided by connecting only the VR-3000 to the battery power pack and operating the recorder in the playback mode.

WARNING

DO NOT OPERATE THE BATTERY POWER PACK IN THE FULLY INVERTED POSITION. TO DO SO WILL CAUSE THE PRESSURE-RELIEF VALVES OF THE CELLS TO BE COVERED WITH ELECTROLYTE, RESULTING IN A DISCHARGE OF THE POTASSIUM HYDROXIDE ELECTROLYTE (INSTEAD OF WATER VAPORS) FROM THE POWER PACK IF AN ACCIDENTAL OVERLOAD CAUSES OVERHEATING.

9-61 BATTERY POWER PACK CELL REPLACEMENT

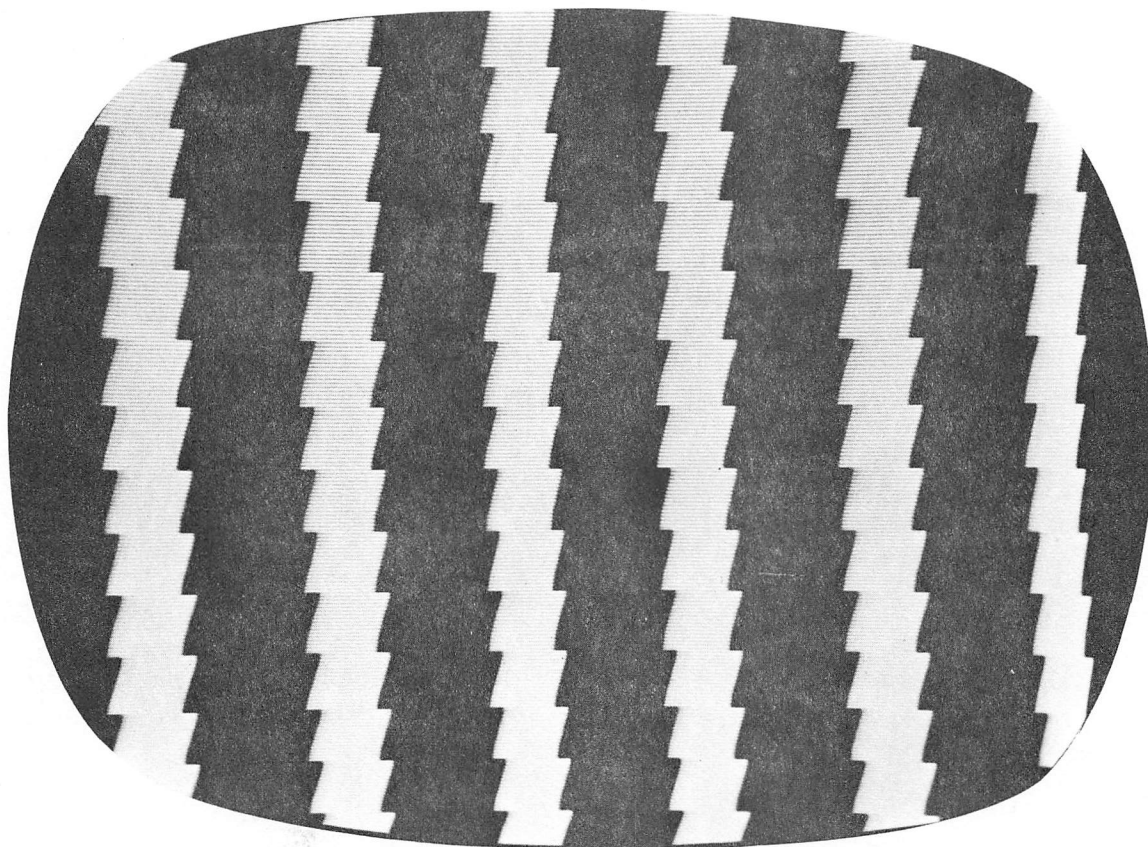
9-62 The battery power pack consists of ten identical silver-cadmium modular cells. Each cell may be removed and replaced independently. To remove and replace a battery power pack cell proceed as follows:

- a. Remove battery power pack cover.
- b. Inspect and clean power pack (see paragraph 9-17).
- c. Disconnect leads to defunct cell.
- d. Cells are snugly fitted into styro-foam. Lift out the cell.
- e. Insert new cell, connect leads, and mount cover.
- f. Connect battery power pack and battery charger. Perform voltage check. Recharge new cell if necessary.

9-63 VACUUM TAPE GUIDE STANDARD POSITION CHECK

9-64 Before recording with the VR-3000, the standard position of the vacuum tape guide should be checked for proper penetration of the tape by the video head tips. When the tip penetration is incorrect, skewing of the reproduced picture results, as illustrated in Figure 9-7. To check the tape guide position, proceed as follows:

- a. Connect a video monitor to VIDEO MONITOR bnc jack J3.



V6708

Figure 9-7. Picture Skewing of Vertical Bar Test Signal

- b. Load a standard alignment tape onto the tape transport.
- c. Press PLAY pushbutton to place recorder in the playback mode.
- d. As the standard alignment tape is being reproduced, observe the video monitor. If skewing is present in the reproduced picture, perform step e.
- e. Slightly loosen the locking screw (see Figure 4-4), then adjust the Allen-head engagement adjustment on the side of the vacuum tape guide until skewing is eliminated.
- f. Tighten locking screw.
- g. At the conclusion of the vacuum guide position check, press the STOP pushbutton. Rewind and remove the tape.

9-65 VIDEO HEAD TRANSFORMER ADJUSTMENT

9-66 The Mark XI Video Head rotary transformer is accurately adjusted at the factory to provide 1 mil separation between rotor and stator. The transformer is adjusted by the slotted-head screw on the end of the transformer cover (see Figure 4-4). If adjustment is required (as indicated by a high speed whine) proceed as follows:

- a. Set recorder POWER switch to OFF.
- b. While manually turning the video head (which is connected to the transformer rotor), slowly turn the slotted-head screw counterclockwise until a drag is just perceptible, then turn it clockwise until the head rotates freely. Continue turning the screw clockwise an additional 1/16 turn (22-1/2 degrees).

9-67 TIP PROJECTION MEASUREMENT

9-68 Tip projection is the distance that the video head tips protrude above a reference surface on the video head drum. The reference surface is on the periphery of the drum

adjacent to the trailing surface of video head number 1. Video head number 1 is identified by a yellow dot. Use special tip projection gauge (1218210-01) for the measurement of tip projection. The gauge is mounted on the video head assembly by means of a knurled screw (captive on the gauge assembly) which engages the mounting bracket (see Figure 4-4). Figure 9-8A shows the gauge correctly mounted for the measurement. To measure tip projection proceed as follows:



DURING THE PERFORMANCE OF THE FOLLOWING MEASUREMENT, USE GREAT CARE TO AVOID CAUSING ANY MECHANICAL DAMAGE TO THE VIDEO HEAD TIPS.

- a. Set recorder POWER switch to OFF.
- b. Turn the video head wheel until head tip number 1 (marked in yellow) just enters the top of the vacuum tape guide.
- c. Mount the tip projection gauge on the head mounting bracket. To do this, hold the gauge in position while engaging the captive knurled-head screw (see Figure 9-8B). Before tightening this screw, center the gauge spindle on the right hand edge of the chrome ridge, then tighten it just enough to hold the gauge firmly in position.
- d. Turn the drum away from the vacuum tape guide, until the tapered screw associated with head tip number 1 is under the gauge contact point. (This centers the gauge contact point on the chrome ridge reference surface.)
- e. Turn the dial of the gauge to place the zero mark in line with the pointer.
- f. To determine the tip projection of head tip number 4, turn the drum very

slowly toward the vacuum tape guide until the gauge pointer registers the maximum indication. Record the indication. (The gauge dial is calibrated in mils and tenths of a mil.) Continue around the drum, noting the maximum indication of each head tip.

g. Continue to turn the head drum slowly (as in step f) until the contact point of the gauge spindle rests on the drum surface midway between head tips 1 and 4; then carefully remove the gauge from the mounting bracket.

9-69 WAVEFORMS

9-70 The following are oscillograms of representative waveforms as they normally appear at test points TP6 through TP20. The test points are mounted on the Test Point Panel (TPP) located in the upper right hand corner of the VR-3000 front panel. A Tektronix Type 597 Oscilloscope with Type 1A1 Preamplifier, and a 10:1 probe was used. In each case, the oscilloscope Horizontal and Vertical settings are shown.

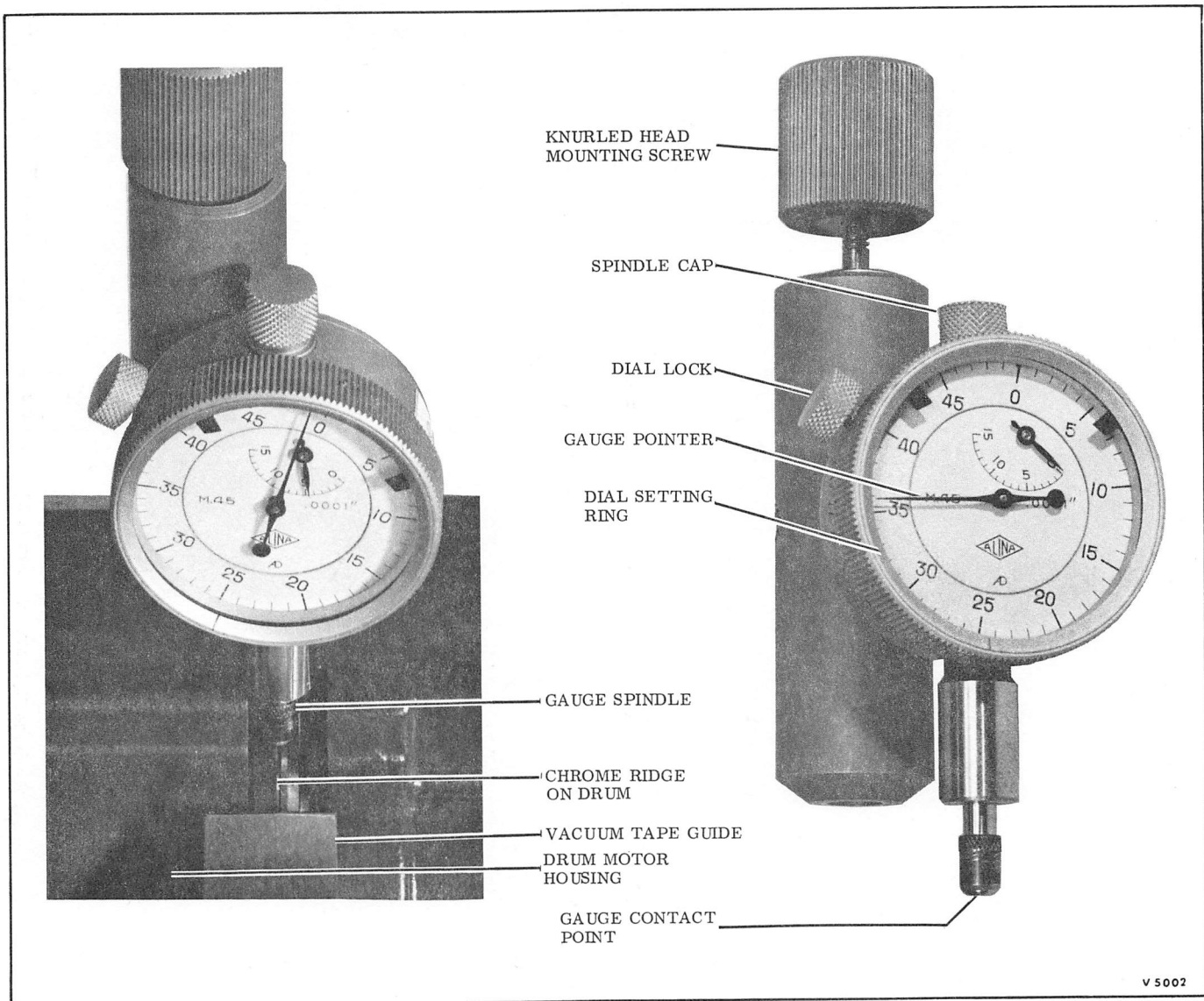
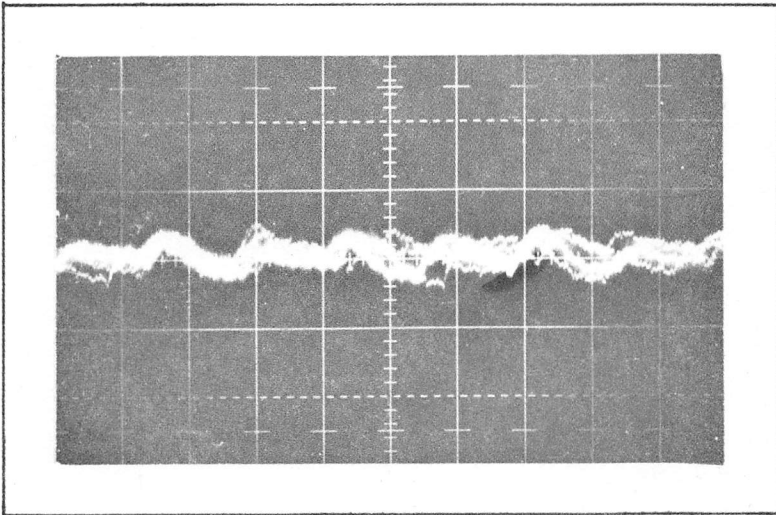
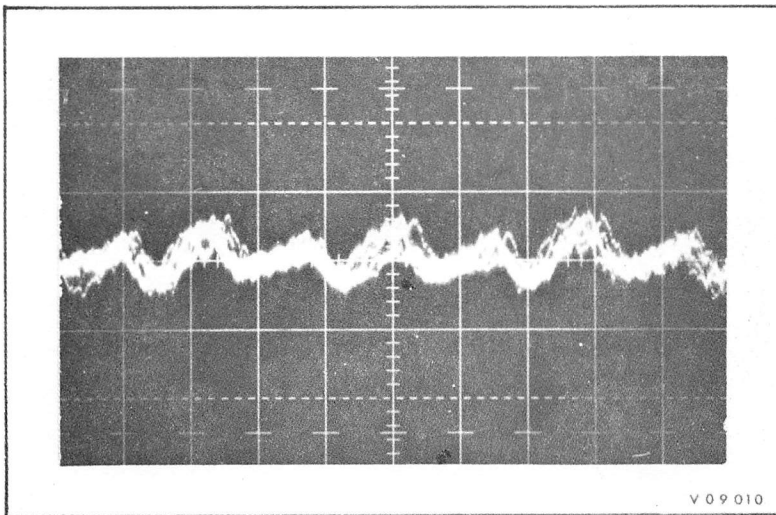


Figure 9-8A. Tip Projection Measurement Test Setup

Figure 9-8B. Tip Projection Gauge



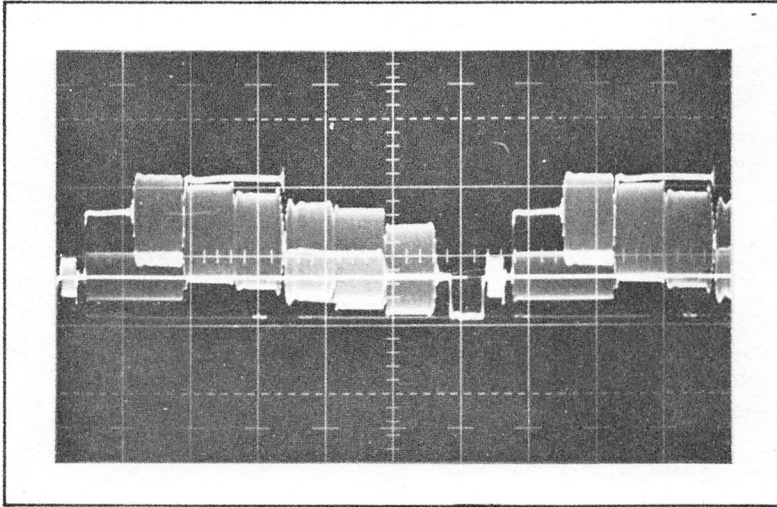
TP6	B+	
Scope:	H=	.5msec/cm
	V=	.005V/cm



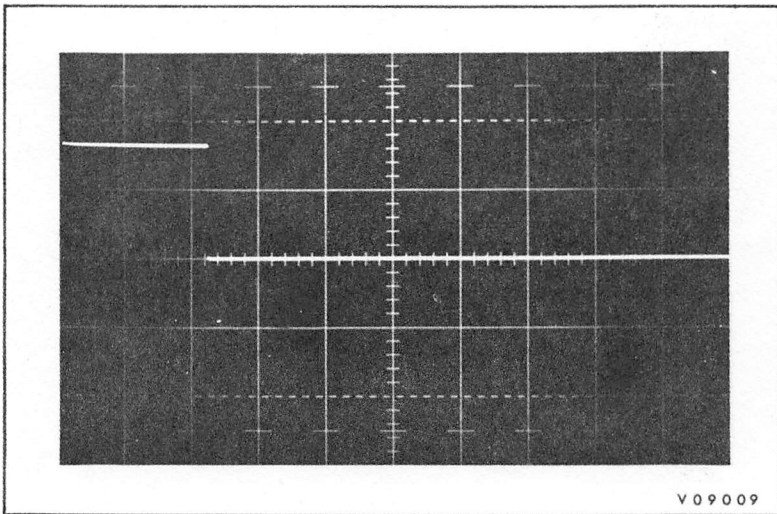
TP7	B-	
Scope:	H=	.5msec/cm
	V=	.005V/cm

V 09010

Figure 9-9. Oscillograms (Sheet 1 of 7)



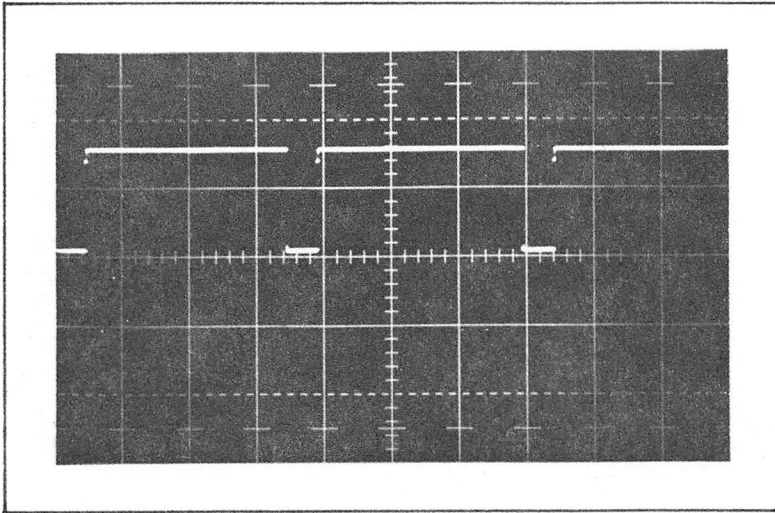
TP8	VIDEO IN
Scope:	H= 20 μ sec/cm
	V= .05V/cm



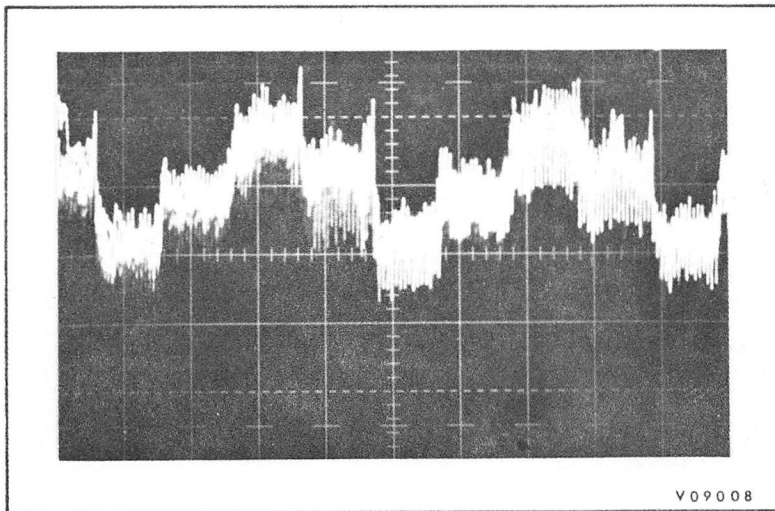
TP9	1/A ROUND
Scope:	H= 50 μ sec/cm
	V= .1V/cm

V09009

Figure 9-9. Oscillograms (Sheet 2 of 7)



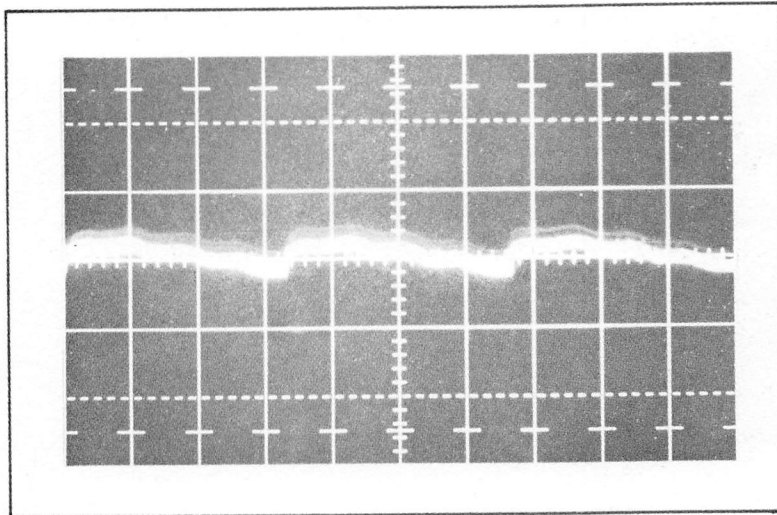
TP10 6 TACH
Scope: H= .2msec/cm
 V= .1V/cm



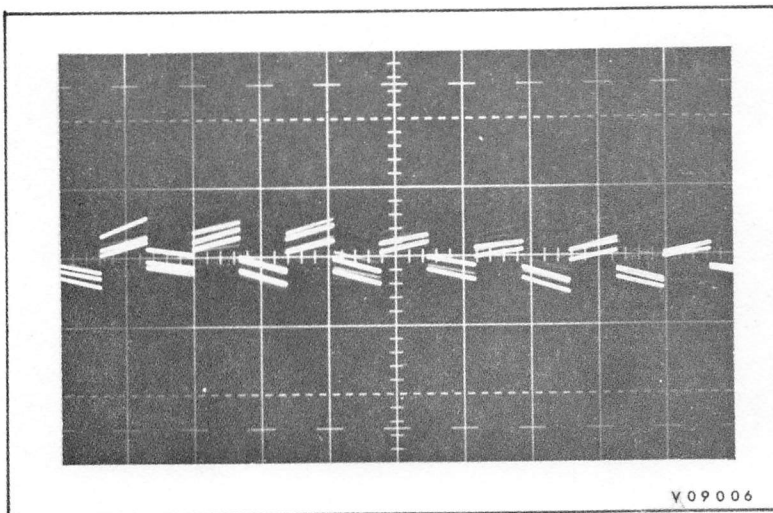
TP11 RF ENV
Scope: H= 1msec/cm
 V= .02V/cm

V09008

Figure 9-9. Oscillograms (Sheet 3 of 7)



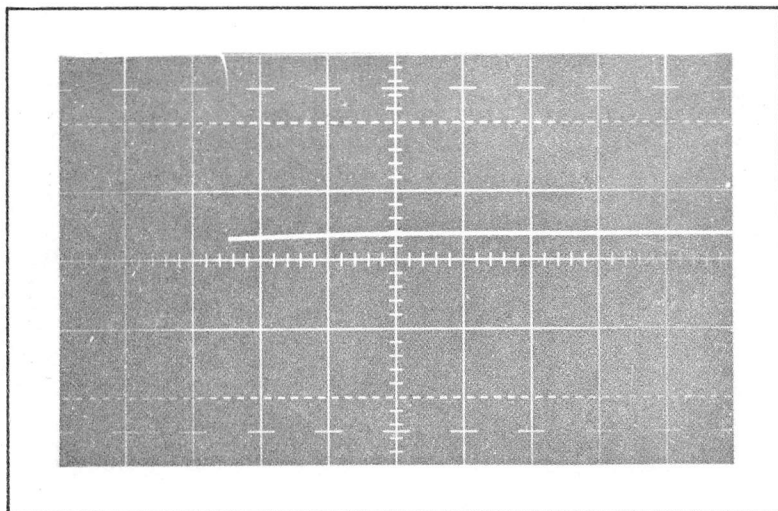
TP12 DRUM ERROR
Scope: H= 5msec/cm
V= .005V/cm
AC coupled



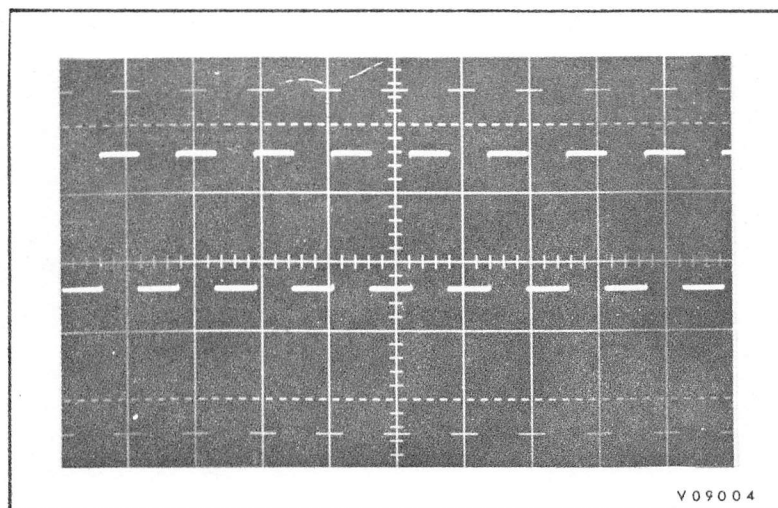
TP13 CAP ERROR
Scope: H= 1msec/cm
V= .05V/cm

V09006

Figure 9-9. Oscillograms (Sheet 4 of 7)



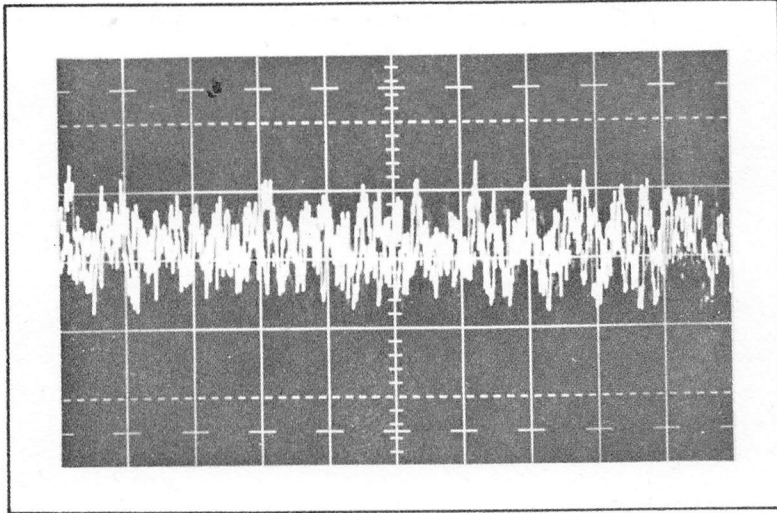
TP14 V PULSE
 Scope: H= .2msec/cm
 V= .05V/cm



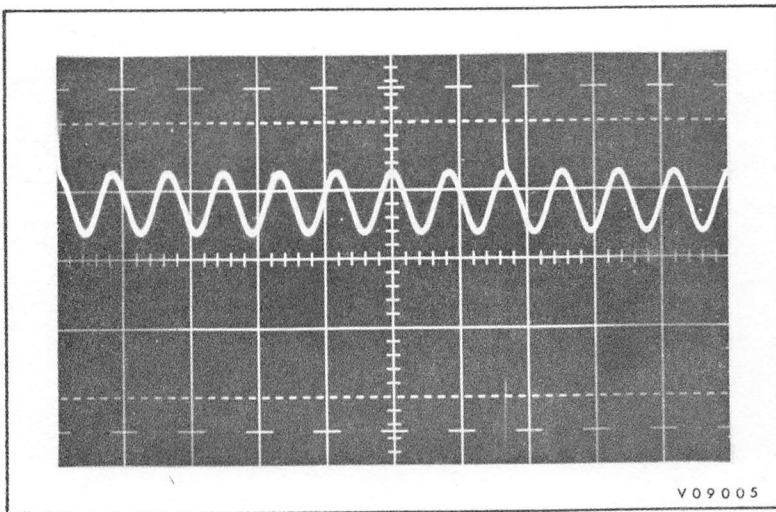
TP15 CAP TACH
 Scope: H= .1msec/cm
 V= .2V/cm

V09004

Figure 9-9. Oscillograms (Sheet 5 of 7)



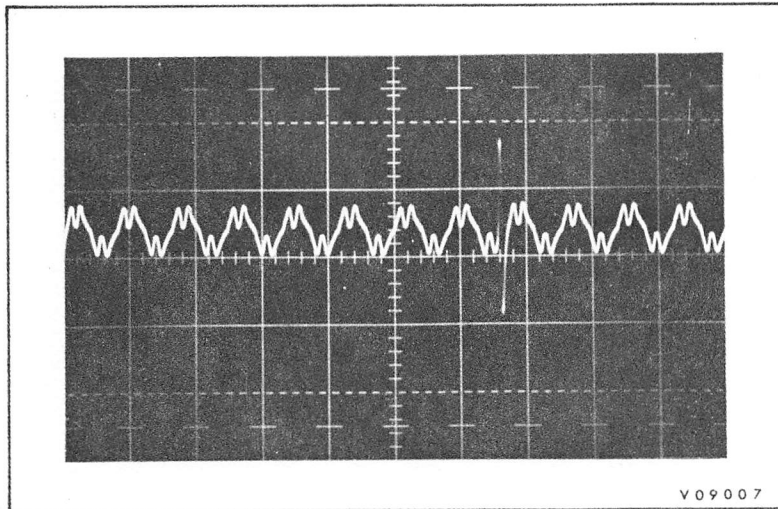
TP16	CAP MOTOR
Scope:	H= 5msec/cm
	V= .1V/cm



TP17	CT REC
Scope:	H= 5msec/cm
	V= .1V/cm

V09005

Figure 9-9. Oscillograms (Sheet 6 of 7)



TP20	CT PB
Scope:	H= 5msec/cm
	V= .05V/cm

Figure 9-9. Oscillograms (Sheet 7 of 7)

SECTION XI

ILLUSTRATED PARTS BREAKDOWN

PART I

Introduction and How to Use.

PART II

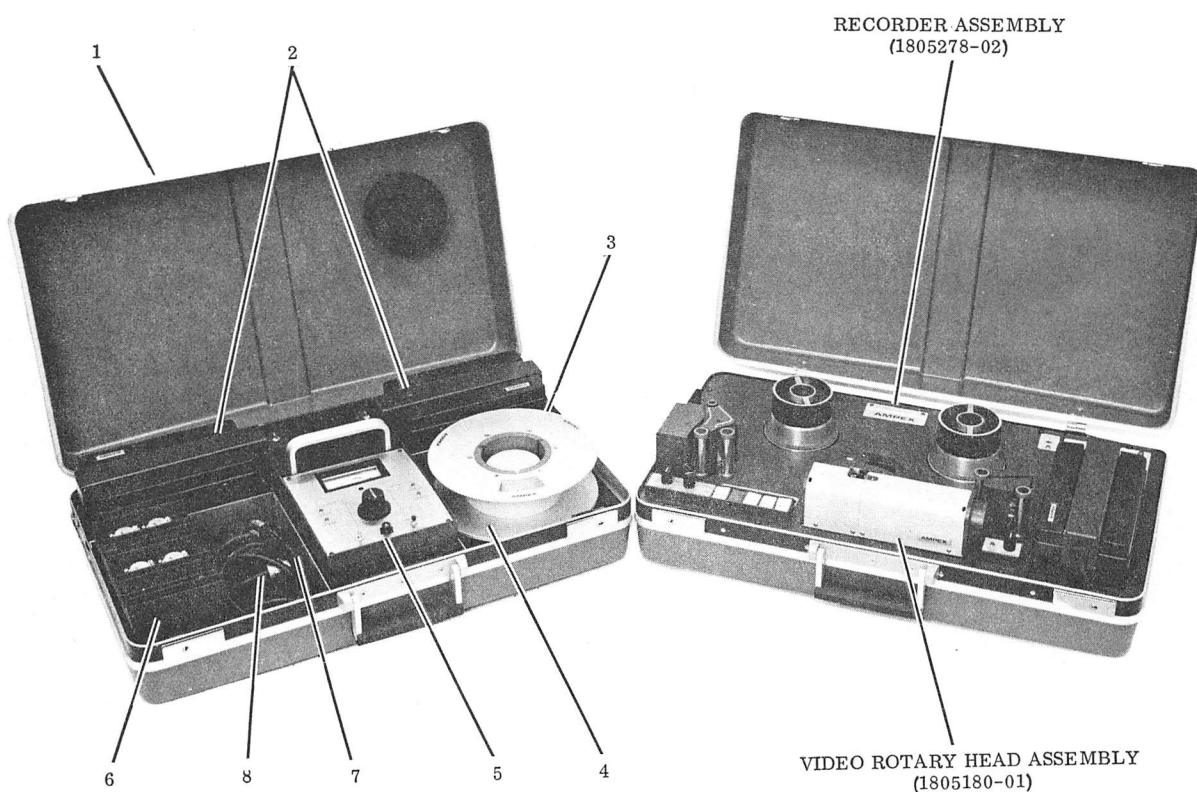
Group Assembly Parts List

PART III

Numerical Index

PART IV

Vendor Information



1 ACCESSORY CASE P/N 1363813-01

CONTENTS:

- 2 BATTERY PACKS (2)
(1805276-01)
- 3 EMPTY 8-INCH REEL
(28050-03)
- 4 BULK 1.4 MIL TAPE -
8-INCH REEL *
(14896-DMIB)
- 5 BATTERY CHARGER UNIT
(1805275)
- 6 BATTERY ELIMINATOR
(1805258)
- 7 POWER CABLE, 115V, 50,
60, 400 Hz (1363360), OR
- 8 POWER CABLE, 220V, 50,
OR 60 Hz (1361361)

* NOTE: BULK TAPE NOT INCLUDED
AS PART OF SYSTEM, MUST BE
CUSTOMER SUPPLIED.

V8966

Figure 11-1. Videotape Recorder Assembly

SECTION XI

ILLUSTRATED PARTS BREAKDOWN

11-1 INTRODUCTION

11-2 This chapter lists, describes, and illustrates the items necessary for the support of the Portable Video Tape Recorder System Model VR-3000, Part Number 1805296, manufactured by Ampex Corporation, Redwood City, California. This section of the manual is used for requisitioning, storing, issuing, and identifying parts in assembly and disassembly sequence.

11-3 This chapter contains group assembly parts lists and supporting illustrations, a numerical index, and vendor information.

11-4 GROUP ASSEMBLY PARTS LISTS

11-5 The group assembly parts list presents a breakdown of all replaceable items listed in disassembly sequence (when disassembly sequence is significant). The information contained in the lists are under the following headings:

- a. Figure and index number
- b. Part number
- c. Asterisk (*)
- d. Description
- e. Units per assembly
- f. Usable on code

11-6 FIGURE AND INDEX NUMBER

11-7 This column will identify the figure which illustrates each listed item and the

index number which identifies the items on the illustration.

11-8 PART NUMBER

11-9 This column will provide the Ampex part number for each item listed in the group assembly parts list.

11-10 ASTERISK (*)

11-11 This column will show an asterisk (*) opposite each Ampex part number that is purchased from a vendor and used without alteration. To obtain vendor information for these parts, refer to the figure and index column for the figure and index number of the part. Refer to the vendor information lists to find the corresponding figure and index number. The vendor part number and vendor address will be shown opposite the figure and index number. Duplicate listings of vendor reference will be referred to the first listing of the vendor by the note "Same as . . ."

11-12 DESCRIPTION

11-13 This column lists items within the equipment in disassembly sequence (where applicable). An indented column arrangement is used to show the relationship between a part and that part's next higher assembly. The top assembly of each listing appears in indentation 1. Primary subassemblies (of the top assembly) and their attaching parts appear in indentation 2. This method of indentation is continued through indentions 3, 4, etc., until all replaceable assemblies, subassemblies, and detail parts have been listed. Attaching parts are listed

immediately following and at the same indentation as the part they attach. Attaching parts are identified by the abbreviation (AP) enclosed in parentheses at the end of the description.

11-14 **UNITS PER ASSEMBLY**

11-15 The quantity shown in this column reflects the total quantity of a part required by that part's next higher assembly. This quantity is not necessarily the total used for the complete equipment (refer to the quantity per article column in the numerical index for total items required per equipment). The abbreviation A/R is used to indicate usage as required of a particular item. The abbreviation REF is used to indicate that the quantity of an item used per assembly is listed in the next higher assembly of the group assembly parts list.

11-16 **USABLE ON CODE**

11-17 This column presents an alphabetic code indicating specific usability of all parts,

when different equipment configurations exist. Where no usable on code appears, the listed part is applicable to all configurations.

11-18 **NUMERICAL INDEX**

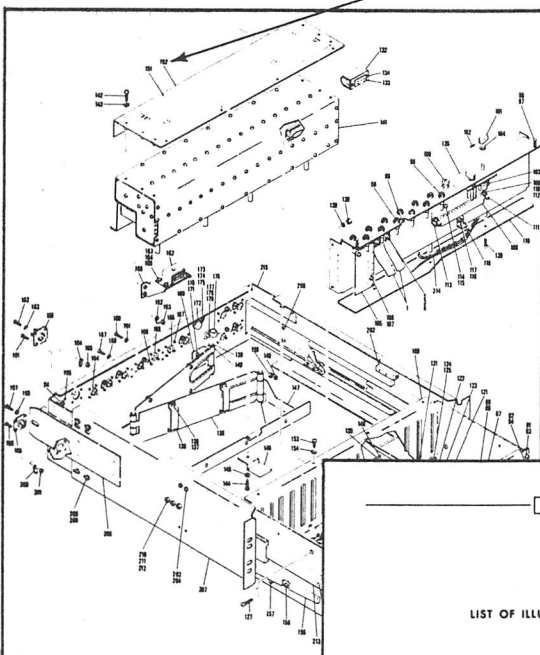
11-19 The numerical index consists of an alpha-numerical listing of all parts of this equipment. Included in this list are the total quantity of a given item shown opposite the first entry with the listing of all other entries for that particular item by figure and index number shown in the group assembly parts list following the first listing.

11-20 **VENDOR INFORMATION**

11-21 This portion lists all vendors' part numbers and names and addresses as required by the listing in the asterisk (*) column of the group assembly parts list.

HOW TO USE THE ILLUSTRATED PARTS BREAKDOWN

2



3

UNIVERSAL COLORTIC CHASSIS ASSEMBLY							INDEX				
FIG. & INDEX NO.	PART NUMBER	1	2	3	4	5	6	7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
19-127	471-236								SCREW, Machine, XRecess, 82 Degree Flat Head, #6-32 x 3/16 Ig (AP)	4	
124	501-003								WASHER, Flat, #6, 0.149 I. D. (AP)	4	
129	430-005								NUT, Assembled Washer, #6-32 (AP)	4	
130	130301-01								BRACKET, Cable Guide	1	
131	472-955								SCREW, Machine, Self-Locking, XRecess, Flat Head, #6-32 x 1/16 Ig (AP)	2	
122	160-942								HOOD, Control	1	
123	140-900								CONNECTOR, Plug (P1)	1	
124	475-026								SCREW, Machine, Assembled Washer, Slot, Pan Head, #4-40 x 1/16 Ig (AP)	2	
125	1263014-01								CLAMP, Harness, Ring	1	
126	475-001								SCREW, Machine, Assembled Washer, XRecess, Pan Head, #4-40 x 1/16 Ig (AP)	4	
127	501-008								WASHER, Flat, #6, 0.125 I. D. (AP)	4	
128	1301000-01								PLATE, Hinge	2	
129	430-005								RING, Retaining, External, 1/4 In. (AP)	4	
140	1301009-01								PIN, Hinge (AP)	1	
141	124000-02								DELAY LINE ASSEMBLY (Factory Service Only)	1	
142	475-054								SCREW, Machine, Assembled Washer, XRecess, Pan Head, #4-40 x 1/16 Ig (AP)	6	
143	502-002								WASHER, Spring Lock, #4 (AP)	6	
144	475-049								SCREW, Machine, Assembled Washer, XRecess, Pan Head, #6-32 x 3/8 Ig (AP)	4	
145	501-003								WASHER, Flat, #6, 0.149 I. D. (AP)	4	
146	1301374-01								CLAMP, Harness	2	
147	1301009-01								BRACKET, Support, Delay Line	1	
148	475-056								SCREW, Machine, XRecess, 82 Degree Flat Head, #6-32 x 9/16 Ig (AP)	4	
149	484-005								WASHER, Flat, #6, 0.149 I. D. (AP)	4	
150	484-005								NUT, Assembled Washer, #6-32 (AP)	4	
151	1301017-01								LABEL, Board Function	1	
152	1301021-01								PLATE, Label	1	
153	415-001								SCREW, Machine, Assembled Washer, XRecess, Pan Head, #4-40 x 1/16 Ig (AP)	4	
154	501-008								WASHER, Flat, #6, 0.125 I. D. (AP)	4	
155	1300023-01								ARM, Latch Release	2	
156	475-036								SCREW, Machine, Assembled Washer, XRecess, Pan Head, #6-32 x 3/16 Ig (AP)	2	
157	501-003								WASHER, Flat, #6, 0.149 I. D. (AP)	2	
									Pin Socket, #4-40 x 1/4 Ig	2	
									Washer, #4-40	2	
									XRecess, 82 Degree Flat Head, 1/2 Ig (AP)	1	
									Pin Latch	1	
									Assembled Washer, XRecess, Pan Head, #4 (AP)	4	
									#6, 0.149 I. D. (AP)	4	
									Washer (AP)	4	
									Pin Support	1	

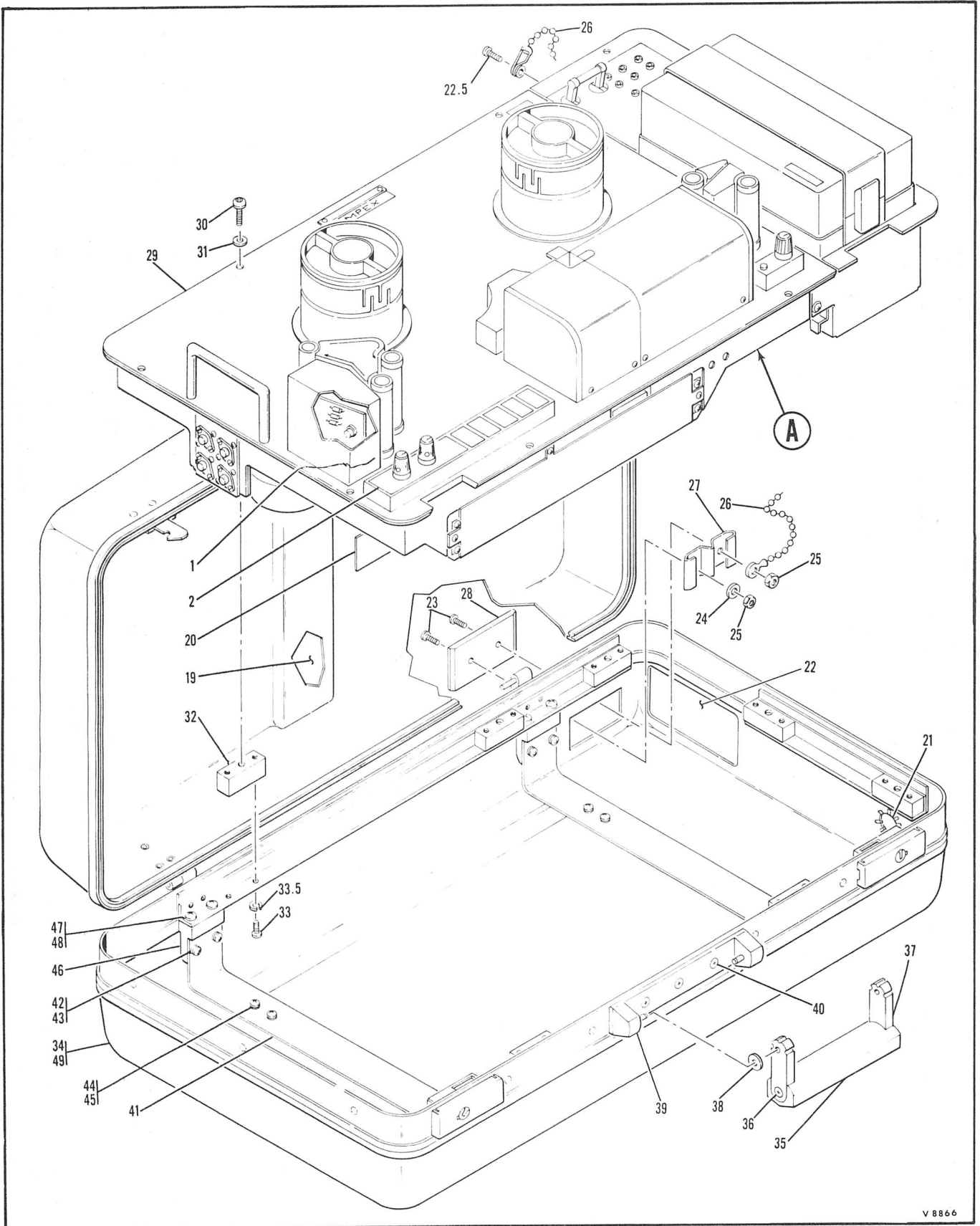
AMPEX

LIST OF ILLUSTRATIONS (Continued)

Figure	Title	Page
7-11	SECAM Switching Sensor Printed Wiring Assembly	7-41
7-12	PAL Switching Sensor Printed Wiring Assembly (Sheet 1 of 2)	7-43
7-13	PAL Switching Sensor Printed Wiring Assembly (Sheet 2 of 2)	7-44
	Burst Sensor/7.5 kHz Shaper Printed Wiring Assembly (Sheet 1 of 2)	7-47
	Burst Sensor/7.5 kHz Shaper Printed Wiring Assembly (Sheet 2 of 2)	7-48
7-14	Input Burst Stripper Printed Wiring Assembly (Sheet 1 of 2)	7-51
7-15	Input Burst Stripper Printed Wiring Assembly (Sheet 2 of 2)	7-52
	Burst Sensor/7.5 kHz Shaper Printed Wiring Assembly (Sheet 1 of 2)	7-55
	Burst Sensor/7.5 kHz Shaper Printed Wiring Assembly (Sheet 2 of 2)	7-56
7-16	Video Input Amplifier/Equalizer Printed Wiring Assembly (Sheet 1 of 2)	7-59
	Video Output Amplifier/Tape Burst Filter Printed Wiring Assembly (Sheet 1 of 2)	7-60
7-17	Output Burst Stripper Printed Wiring Assembly (Sheet 1 of 2)	7-63
7-18	Output Burst Stripper Printed Wiring Assembly (Sheet 2 of 2)	7-64
7-19	Relay Control Board Printed Wiring Assembly	7-67
	Universal Colortic Chassis Assembly (Sheet 1 of 2)	7-68
	Universal Colortic Chassis Assembly (Sheet 2 of 2)	7-69

WHEN THE PART NUMBER IS NOT KNOWN

1. Determine the function and application of the part required. Turn to the Table of Contents and select the most appropriate title. Note the illustration page number.
2. Turn to the page indicated and locate the desired part on the illustration.
3. From the Illustration, obtain the Index Number assigned to the part desired. Refer to the accompanying nomenclature for specific information regarding the part.

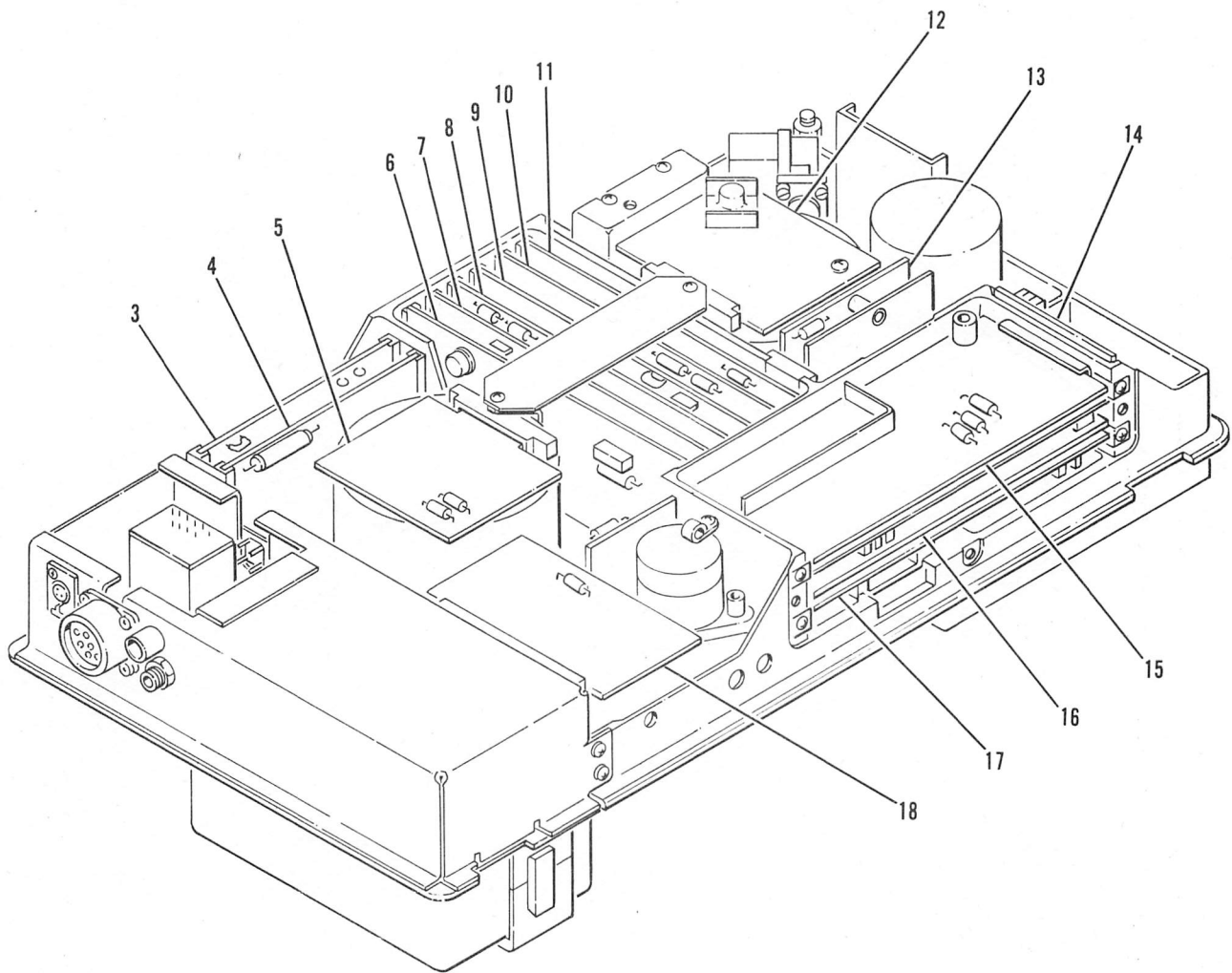


V 8866

Figure 11-2. Recorder Assembly (Sheet 1 of 2)

A

ROTATED 180°



V 8867

Figure 11-2. Recorder Assembly (Sheet 2 of 2)

RECORDER ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2	1805278-02			RECORDER ASSEMBLY (See Figure 1- For Next Higher Assembly)	Ref	
-1	1361590-01			. PRINTED WIRING ASSEMBLY, Audio Head Drive (See Figure 3 For Details)	1	
-2	1361693-01			. OVERLAY, Left, Transport Control.	1	A
-3	1361657-01			. PRINTED WIRING ASSEMBLY, Standards (525HB-525LB) . . . (See Figure 4 For Details)	1	A
	1361693-02			. OVERLAY, Left, Transport Control.	1	B
	1361657-02			. PRINTED WIRING ASSEMBLY, Standards (625HB-625LB) . . . (See Figure 5 For Details)	Ref	B
	1361693-03			. OVERLAY, Left, Transport Control.	1	C
	1361657-03			. PRINTED WIRING ASSEMBLY, Standards (819HB-819LB) . . . (See Figure 6 For Details)	1	C
	1361693-04			. OVERLAY, Left, Transport Control.	1	D
	1361657-04			. PRINTED WIRING ASSEMBLY, Standards (625HB-405LB) . . . (See Figure 7 For Details)	1	D
	1361693-05			. OVERLAY, Left, Transport Control.	1	E
	1361657-05			. PRINTED WIRING ASSEMBLY, Standards (625HB-819HB) . . . (See Figure 8 For Details)	1	E
-4	1361582-02			. PRINTED WIRING ASSEMBLY, Input/Output Video (See Figure 9 For Details)	1	
-5	1363796-01			. PRINTED WIRING ASSEMBLY, Supply Motor (See Figure 10. . For Details)	1	
-5.1	475-001			. SCREW, Pan Head, Xrecess, Sem, 4-40 x 1/4 Lg (AP)	1	
-5.2	501-169			. WASHER, Flat, #4, Small Pattern	1	
-6	1361558-01			. PRINTED WIRING ASSEMBLY, Drum MDA Driver (See Figure 11 For Details)	1	
-7	1361560-02			. PRINTED WIRING ASSEMBLY, Head Drum Servo (See Figure 12 For Details)	1	
-8	1361564-01			. PRINTED WIRING ASSEMBLY, Control Track (See Figure 13 For Details)	1	
-9	1361562-01			. PRINTED WIRING ASSEMBLY, Capstan Servo (See Figure 14 For Details)	1	
-10	1361566-01			. PRINTED WIRING ASSEMBLY, Control Logic (See Figure 15 For Details)	1	
-11	1361588-01			. PRINTED WIRING ASSEMBLY, 12 Volt Regulator (See Figure 16 For Details)	1	
-12	1363799-01			. PRINTED WIRING ASSEMBLY, Take Up Motor (See. Figure 17 For Details)	1	
-12.1	472-448			. SCREW, Pan Head, Xrecess, 2-56 x 5/8 Lg (AP)	1	
-12.2	502-001			. WASHER, Lock, Spring, #2 (AP)	1	
-12.3	475-001			. SCREW, Pan Head, Xrecess, Sem, 4-40 x 1/4 Lg (AP)	2	
-12.4	501-169			. WASHER, Flat, #4, Small Pattern	2	
-13	1361738-01			. PRINTED WIRING ASSEMBLY, Power Distribution (See. . . . Figure 18 For Details)	1	
-14	1361592-02			. PRINTED WIRING ASSEMBLY, Audio AGC Amplifier (See. . . Figure 19 For Details)	1	
-15	1361580-01			. PRINTED WIRING ASSEMBLY, Demodulator/Filter Amplifier . (See Figure 20 For Details)	1	
-16	1361578-01			. PRINTED WIRING ASSEMBLY, Switcher/Equalizer (See. . . . Figure 21 For Details)	1	
-17	1361576-02			. PRINTED WIRING ASSEMBLY, Modulator Preamplifier. . . . (See Figure 22 For Details)	1	
-18	1361556-01			. PRINTED WIRING ASSEMBLY, MDA Head Drum (See Figure 23 For Details)	1	
-19	1363399-01			. LABEL, Trademark, Luggage Case.	1	
-20	6000035-01			. LABEL, Identification	1	
-21	1363403-01			. PLUG, Button	1	
-22	1363367-01			. COVER ASSEMBLY, Connector, Transport Case	1	
-22.5	476-024			. SCREW, Self-Tapping, Pan Head, #4 x 1/4 Lg (AP).	1	
-23	471-327			. . SCREW, Machine, Flat Head, Xrecess, 4-40 x 0.312 Lg . .	2	
-24	501-637			. . WASHER, Flat, #4	1	
-25	496-004			. . NUT, Assembled Washer, 4-40	2	
-26	510-012			. . BEAD ASSEMBLY, Chain	1	

RECORDER ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2-27	1363409-01			. . SPRING, Connector, Transport Case.	1	
-28	1363410-01			. . PLATE, Connector, Transport Case.	1	
-29	1361550-02			. TAPE TRANSPORT ASSEMBLY (See Figure 24 For Details. . .	1	
-30	470-475			. SCREW, Cap, Hexagon Socket, 6-32 x 1/2 Lg (AP).	9	
-31	501-684			. WASHER, Flat, Nylon, Black, #6, 0.150 I.D. (AP)	9	
-32	1363400-01			. MOUNT, Transport	9	
-33	471-062			. SCREW, Machine, Pan Head, 4-40 x 3/8 Lg (AP)	18	
-33.5	502-002			. WASHER, Lock, Spring, #4, 0.115 I.D. (AP)	18	
-34	1363811-01			. CASE, Luggage (See Figure For Details)	1	
-35	1361729-01			. . HANDLE, Luggage Case	1	
-36	471-976			. . SCREW, Cap, Flat Head, Hex Socket Drive, ... 6-32 x 5/8 Lg (AP)	2	
-37	1361730-01			. . SUPPORT, Handle	2	
-38	501-221			. . WASHER, Teflon	AR	
-39	1361727-01			. . BASE, Handle Mounting.	1	
-40	471-388			. . SCREW, Flat Head, Xrecess, 6-32 x 7/16 Lg (AP)	3	
-41	1363817-01			. . STRAP, Recorder Case.	2	
-42	471-068			. . SCREW, Pan Head, Xrecess, 6-32 x 5/16 Lg (AP).	8	
-43	502-025			. . WASHER, Lock, Internal Tooth, #6 (AP)	8	
-44	471-061			. . SCREW, Pan Head, Xrecess, 4-40 x 5/16 Lg (AP).	8	
-45	502-024			. . WASHER, Lock, Internal Tooth, #4 (AP)	8	
-46	1363816-01			. . BLOCK, Support	4	
-47	471-069			. . SCREW, Pan Head, Xrecess, 6-32 x 3/8 Lg (AP)	8	
-48	502-025			. . WASHER, Lock, Internal Tooth, #6 (AP)	8	
-49	1363810-01			. . CASE, Recorder	1	

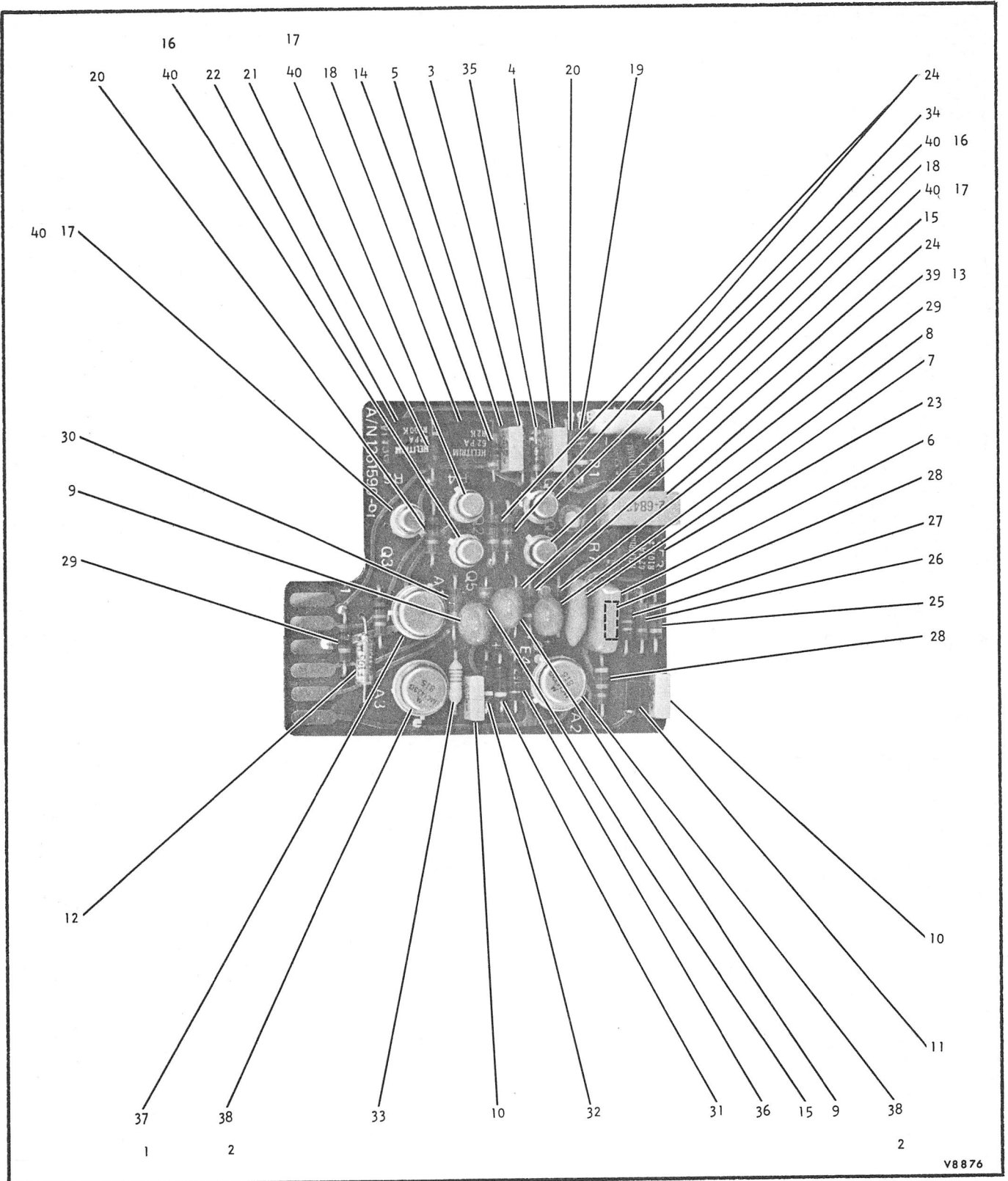


Figure 11-3. Audio Head Drive (Board 25)

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
3	1361590-01			PRINTED WIRING ASSEMBLY, Audio Head Drive (See Figure 2-3 For Next Higher Assembly)	Ref	
-1	586-019	∞		. CIRCUIT, Integrated (A1).	1	
-2	586-161	∞		. CIRCUIT, Integrated (A2,3).	2	
-3	013-689			. DIODE (CR1)	1	
-4	030-495			. CAPACITOR, Ceramic, 0.01μF, 200V, 10% (C1)	1	
-5	030-163			. CAPACITOR, Ceramic, 2700PF, 200V, 5% (C2)	1	
-6	030-223			. CAPACITOR, Ceramic, 2.2μF, 25V, 20% (C3)	1	
-7	030-144			. CAPACITOR, Ceramic, 0.05μF, 100V, 20% (C4)	1	
-8	037-617			. CAPACITOR, Tantalum, 47μF, 15V, 20% (C5)	1	
-9	037-596			. CAPACITOR, Tantalum, 33μF, 15V, 20% (C6,7)	2	
-10	030-885			. CAPACITOR, Ceramic, 2200PF, 200V, 5% (C8,10)	2	
-11	030-829			. CAPACITOR, Ceramic, 10PF, 200V, 10% (C9)	1	
-12	037-058			. CAPACITOR, Tantalum, 1μF, 35V, 20% (C11)	1	
-13	020-562			. RELAY (K1)	1	
-14	051-633			. INDUCTOR, 1MH, 10% (L1).	1	
-15	051-569	∞		. INDUCTOR, 100μH, 10% (L2,3)	2	
-16	014-505			. TRANSISTOR (Q1,5)	2	
-17	014-506			. TRANSISTOR (Q2-4)	3	
-18	058-347			. RESISTOR, Variable, 2000 Ohm, 1/2W, 30% (R1,4)	2	
-19	057-060			. RESISTOR, Metal Film, 33 Ohm, 1/4W, 2% (R2)	1	
-20	041-419			. RESISTOR, Carbon Composition, 100 Ohm, 1/4W, 5% (R3,10)	2	
-21	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, 5% (R5).	1	
-22	058-124			. RESISTOR, Variable, 100000 Ohm, 1/2W, 30% (R6)	1	
-23	058-333			. RESISTOR, Variable, 10000 Ohm, 1/2W, 30% (R7)	1	
-24	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, 5% (R8,9, ... 16)	3	
-25	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, 5% (R11).	1	
-26	041-771			. RESISTOR, Carbon Composition, 1.1 Megohm, 1/4W, 5% (R12)	1	
-27	041-508			. RESISTOR, Carbon Composition, 20000 Ohm, 1/4W, 5%. R13,18)	2	
-28	041-411			. RESISTOR, Carbon Composition, 47000 Ohm, 1/4W, 5%. R14,20)	2	
-29	041-496			. RESISTOR, Carbon Composition, 10 Ohm, 1/4W, 5% (R15,19)	2	
-30	041-504			. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, 5% (R17)	1	
-31	057-100			. RESISTOR, Metal Film, 1500 Ohm, 1/4W, 2% (R21).	1	
-32	057-113			. RESISTOR, Metal Film, 5100 Ohm, 1/4W, 2% (R22).	1	
-33	057-104			. RESISTOR, Metal Film, 2200 Ohm, 1/4W, 2% (R23).	1	
-34	148-028	∞		. TEST POINT, Tip Jack, Connector, White (TP1)	1	
-35	013-625			. DIODE (1N823A) (VR1)	1	
-36	013-167			. DIODE (VR2)	1	
-37	586-160	∞		. PAD, Mounting, Integrated Circuit	1	
-38	586-149	∞		. PAD, Mounting, Integrated Circuit	2	
-39	1363640-01			. INSULATOR, Relay	1	
-40	280-130	∞		. PAD, Transistor Mounting	5	
-41	1361591-01			. PRINTED WIRING BOARD	1	

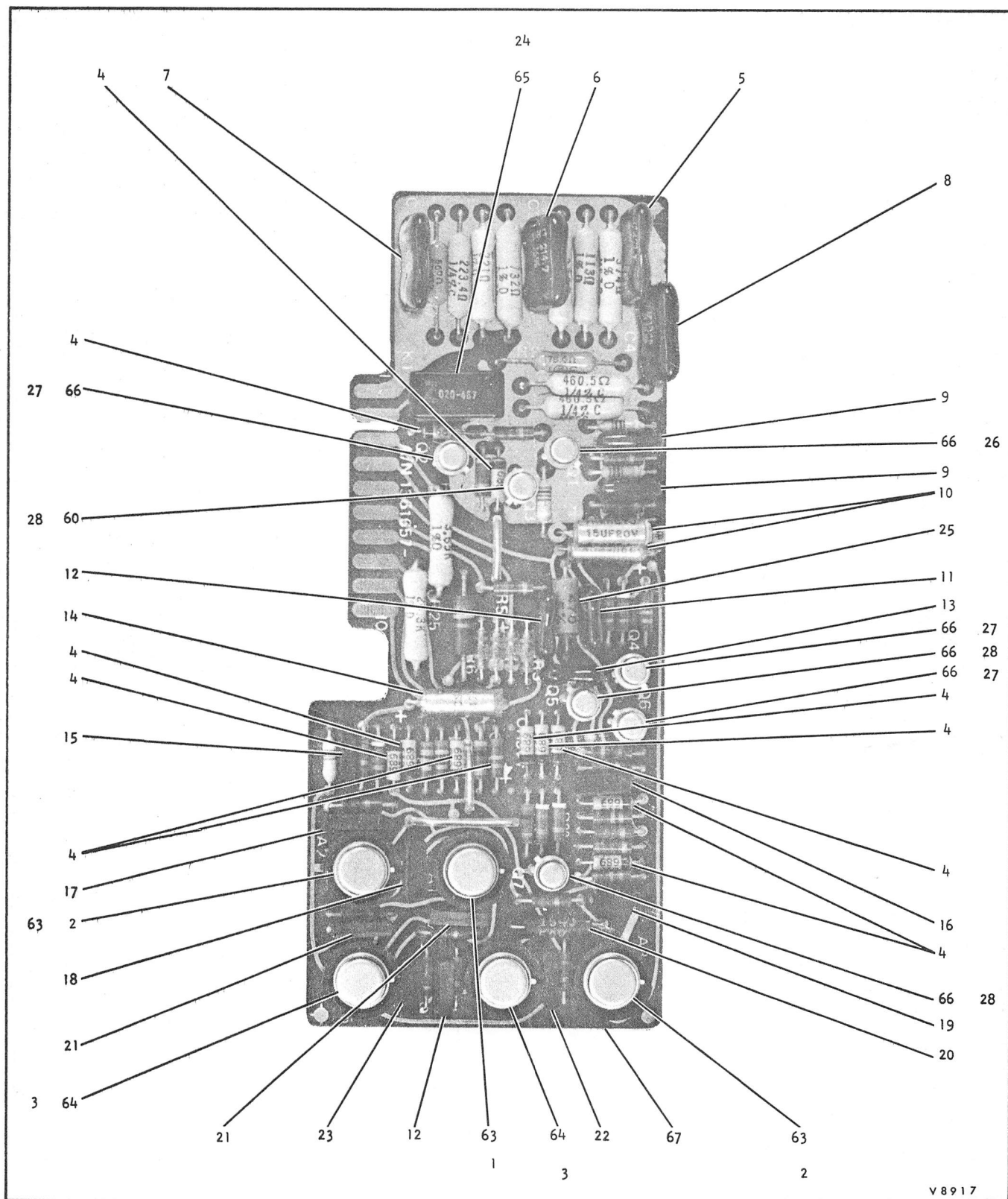


Figure 11-4. PWA Standards (525 HB-525 LB) (Board 19) (Sheet 1 of 2)

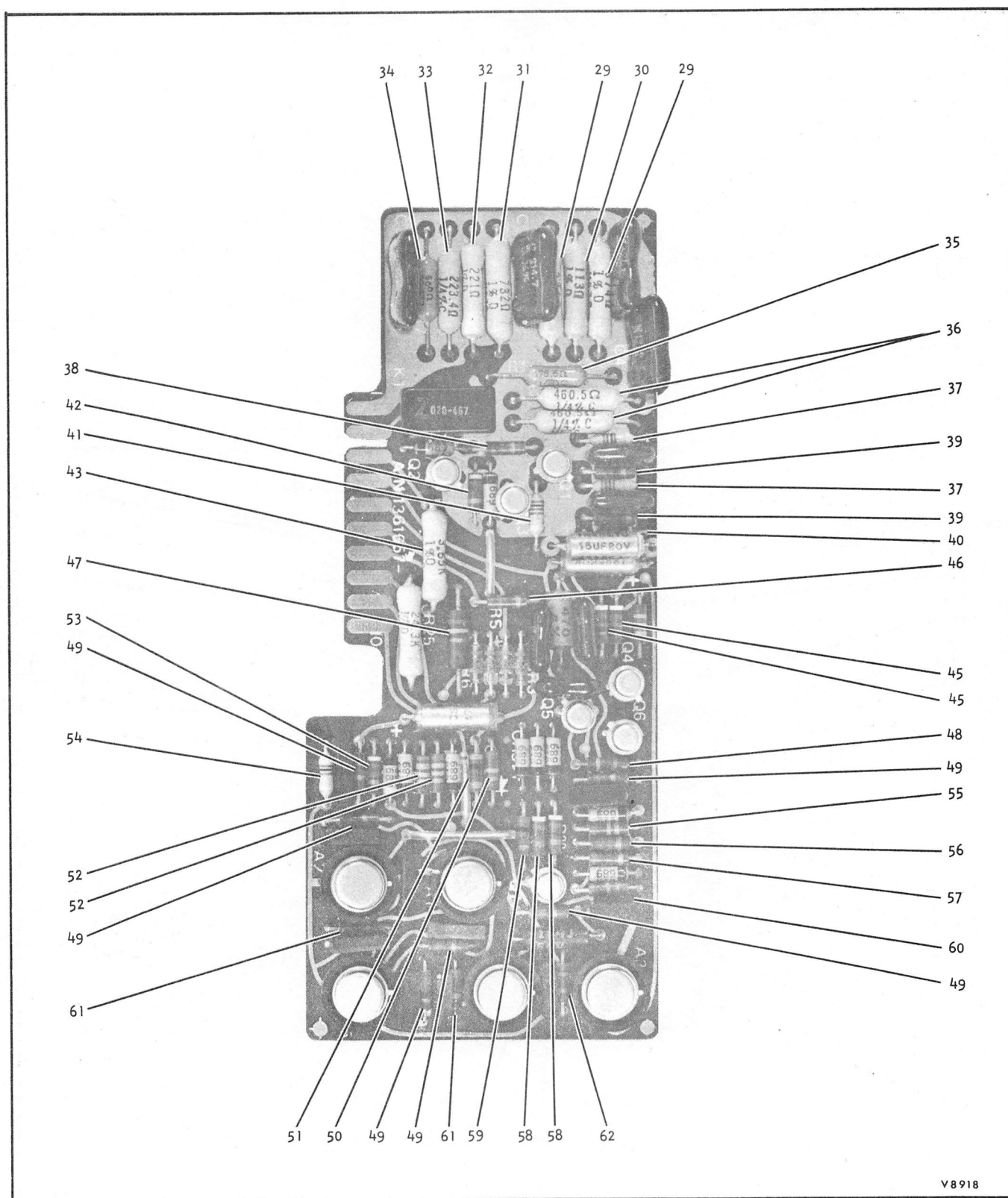


Figure 11-4. PWA Standards (525 HB-525 LB) (Board 19) (Sheet 2 of 2)

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
4	1361657-01			PRINTED WIRING ASSEMBLY, Standards (525HB-525LB) (See Figure 2-3 For Next Higher Assembly)	Ref	A
-1	586-020	∴		. CIRCUIT, Integrated (A1).	1	A
-2	586-051	∴		. CIRCUIT, Integrated (A2,3).	2	A
-3	586-021	∴		. CIRCUIT, Integrated (A4,5).	2	A
-4	013-689			. DIODE (CR1,2,7-15)	11	A
-5	034-773			. CAPACITOR, Mica, 335.2PF, 500V, 1/2% (C1).	1	A
-6	034-768			. CAPACITOR, Mica, 207.9PF, 500V, 1/2% (C2).	1	A
-7	034-779			. CAPACITOR, Mica, 1471PF, 500V, 1/2% (C3).	1	A
-8	034-775			. CAPACITOR, Mica, 979.6PF, 500V, 1/2% (C4).	1	A
-9	034-945			. CAPACITOR, Mica, 12PF, 500V, 5% (C5,6)	2	A
-10	037-068			. CAPACITOR, Tantalum, 15μF, 20V, 20% (C7,8)	2	A
-11	034-181			. CAPACITOR, Mica, 47PF, 500V, 5% (C9)	1	A
-12	034-212			. CAPACITOR, Mica, 330PF, 500V, 5% (C10)	1	A
-13	034-962			. CAPACITOR, Mica, 33PF, 500V, 5% (C11)	1	A
-14	037-085			. CAPACITOR, Tantalum, 47μF, 6V, 20% (C12)	1	A
-15	055-200			. CAPACITOR, Mylar, 0.0039μF, 50V, 3% (C13)	1	A
-16	035-828			. CAPACITOR, Mylar, 0.022μF, 50V, 5% (C14)	1	A
-17	035-843			. CAPACITOR, Mylar, 0.0015μF, 50V, 10% (C15)	1	A
-18	055-144			. CAPACITOR, Mylar, 0.012μF, 50V, 5% (C16)	1	A
-19	035-817			. CAPACITOR, Mylar, 0.015μF, 50V, 5% (C17)	1	A
-20	030-883			. CAPACITOR, Ceramic, 0.15μF, 50V, 5% (C18).	1	A
-21	055-166			. CAPACITOR, Mylar, 0.001μF, 50V, 5% (C19,20,22)	3	A
-22	055-604			. CAPACITOR, Mylar, 0.0018μF, 50V, 5% (C21)	1	A
-23	035-815			. CAPACITOR, Mylar, 0.027μF, 50V, 5% (C23)	1	A
-24	020-467			. RELAY (K1)	1	A
-25	540-007	∴		. INDUCTOR, 470μH, 5% (L1)	1	A
-26	014-581			. TRANSISTOR (Q1)	1	A
-27	014-505			. TRANSISTOR (Q2,4,6)	3	A
-28	014-506			. TRANSISTOR (Q3,5,7)	3	A
-29	057-448			. RESISTOR, Metal Film, 555 Ohm, 1/2W, 1% (R1,3).	2	A
-30	057-978			. RESISTOR, Metal Film, 78.7 Ohm, 1/2W, 1% (R2)	1	A
-31	057-380			. RESISTOR, Metal Film, 634 Ohm, 1/2W, 1% (R4)	1	A
-32	047-890			. RESISTOR, Wirewound, 8.72 Ohm, 1/4W, 1/4% (R5)	1	A
-33	048-840			. RESISTOR, Metal Film, 121.9 Ohm, 1/4W, 1/4% (R6)	1	A
-34	048-847			. RESISTOR, Metal Film, 407.8 Ohm, 1/4W, 1/4% (R7)	1	A
-35	048-845			. RESISTOR, Metal Film, 245.0 Ohm, 1/4W, 1/4% (R8)	1	A
-36	048-854			. RESISTOR, Metal Film, 660.0 Ohm, 1/4W, 1/4% (R9,10)	2	A
-37	057-068			. RESISTOR, Metal Film, 68 Ohm, 1/4W, 2% (R11,14)	2	A
-38	041-414			. RESISTOR, Carbon Composition, 2200 Ohm, 1/4W, 5% (R12)	1	A
-39	041-647			. RESISTOR, Carbon Composition, 75 Ohm, 1/4W, 5% (R13,15)	2	A
-40	057-097			. RESISTOR, Metal Film, 1100 Ohm, 1/4W, 2% (R16).	1	A
-41	057-096			. RESISTOR, Metal Film, 1000 Ohm, 1/4W, 2% (R17).	1	A
-42	041-412			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, 5% (R18).	1	A
-43	048-821			. RESISTOR, Metal Film, 3480 Ohm, 1/2W, 1% (R19).	1	A
-44	041-750			. RESISTOR, Carbon Composition, 24000 Ohm, 1/4W, 5% (R20)	1	A
-45	041-532			. RESISTOR, Carbon Composition, 910 Ohm, 1/4W, 5% (R21,22).	2	A
-46	041-434			. RESISTOR, Carbon Composition, 1800 Ohm, 1/4W, 5% (R23).	1	A
-47	041-323			. RESISTOR, Carbon Composition, 270000 Ohm, 1/2W, 5% (R24).	1	A
-48	041-570			. RESISTOR, Carbon Composition, 2400 Ohm, 1/4W, 5% (R26).	1	A
-49	041-561			. RESISTOR, Carbon Composition, 5100 Ohm, 1/4W, 5% (R27,33,41,43,45,48)	6	A
-50	041-409			. RESISTOR, Carbon Composition, 15000 Ohm, 1/4W, 5% (R28)	1	A
-51	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, 5% (R29).	1	A
-52	041-549			. RESISTOR, Carbon Composition, 13000 Ohm, 1/4W, 5%. R30,31)	2	A
-53	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, 5% (R32)	1	A
-54	057-071			. RESISTOR, Metal Film, 91 Ohm, 1/4W, 2% (R34)	1	A
-55	041-573			. RESISTOR, Carbon Composition, 75000 Ohm, 1/4W, 5% (R35)	1	A

PRINTED WIRING ASSEMBLY

1809993

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
4-56	041-504			. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, 5% (R36). . .	1	A
-57	041-495			. RESISTOR, Carbon Composition, 8200 Ohm, 1/4W, 5% (R37) . .	1	A
-58	041-514			. RESISTOR, Carbon Composition, 9100 Ohm, 1/4W, 5% (R38,39).	2	A
-59	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, 5% (R40) . .	1	A
-60	041-753			. RESISTOR, Carbon Composition, 62000 Ohm, 1/4W, 5% (R42). .	1	A
-61	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, 5% (R44,47).	2	A
-62	041-437			. RESISTOR, Carbon Composition, 1600 Ohm, 1/4W, 5% (R46) . .	1	A
-63	280-174	✧		. SPACER, Integrated Circuit	3	A
-64	280-173	✧		. SPACER, Integrated Circuit	2	A
-65	1360036-01			. INSULATOR, Relay	1	A
-66	280-130	✧		. PAD, Transistor Mounting.	7	A
-67	1361585-01			. PRINTED WIRING BOARD.	1	A

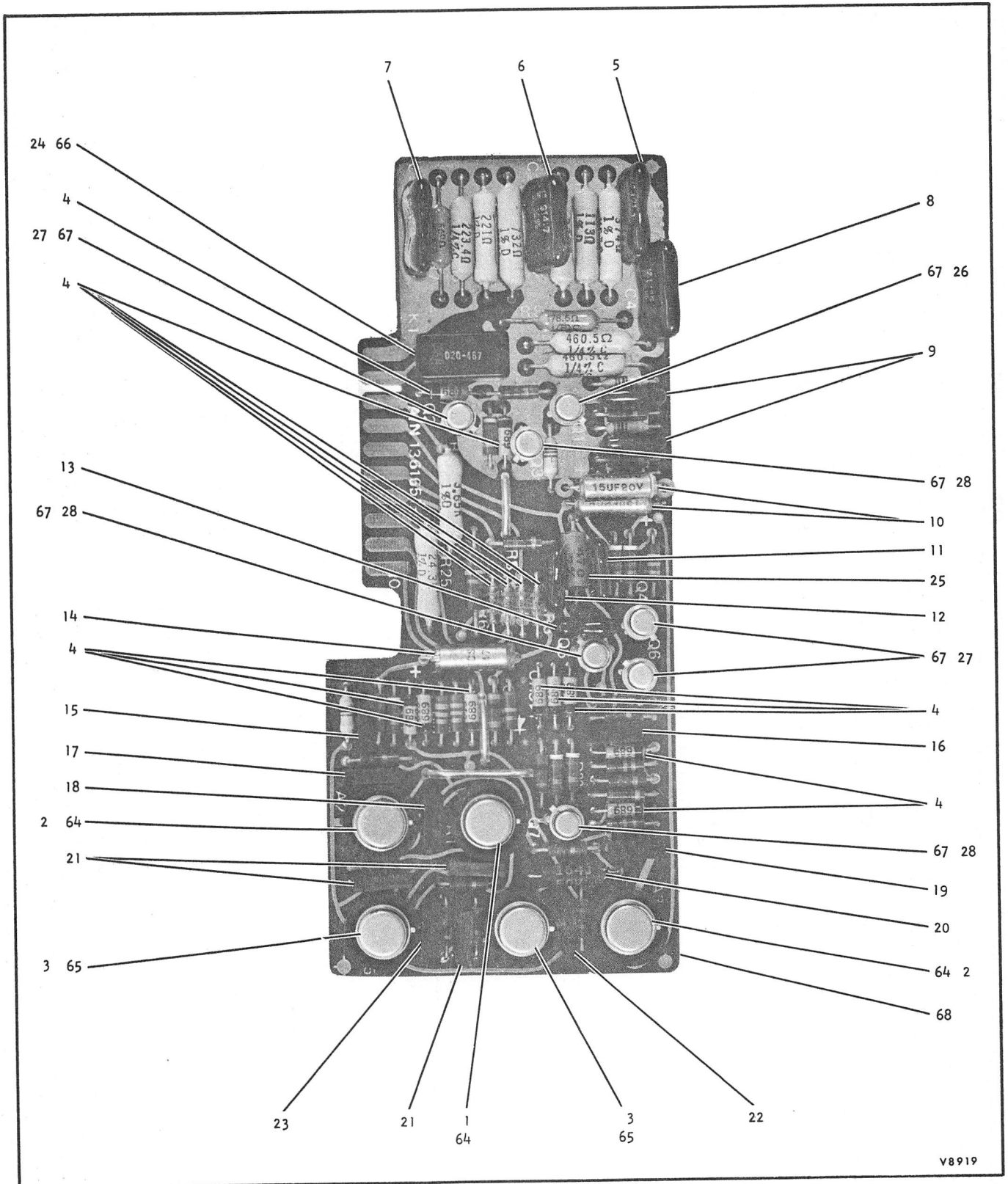
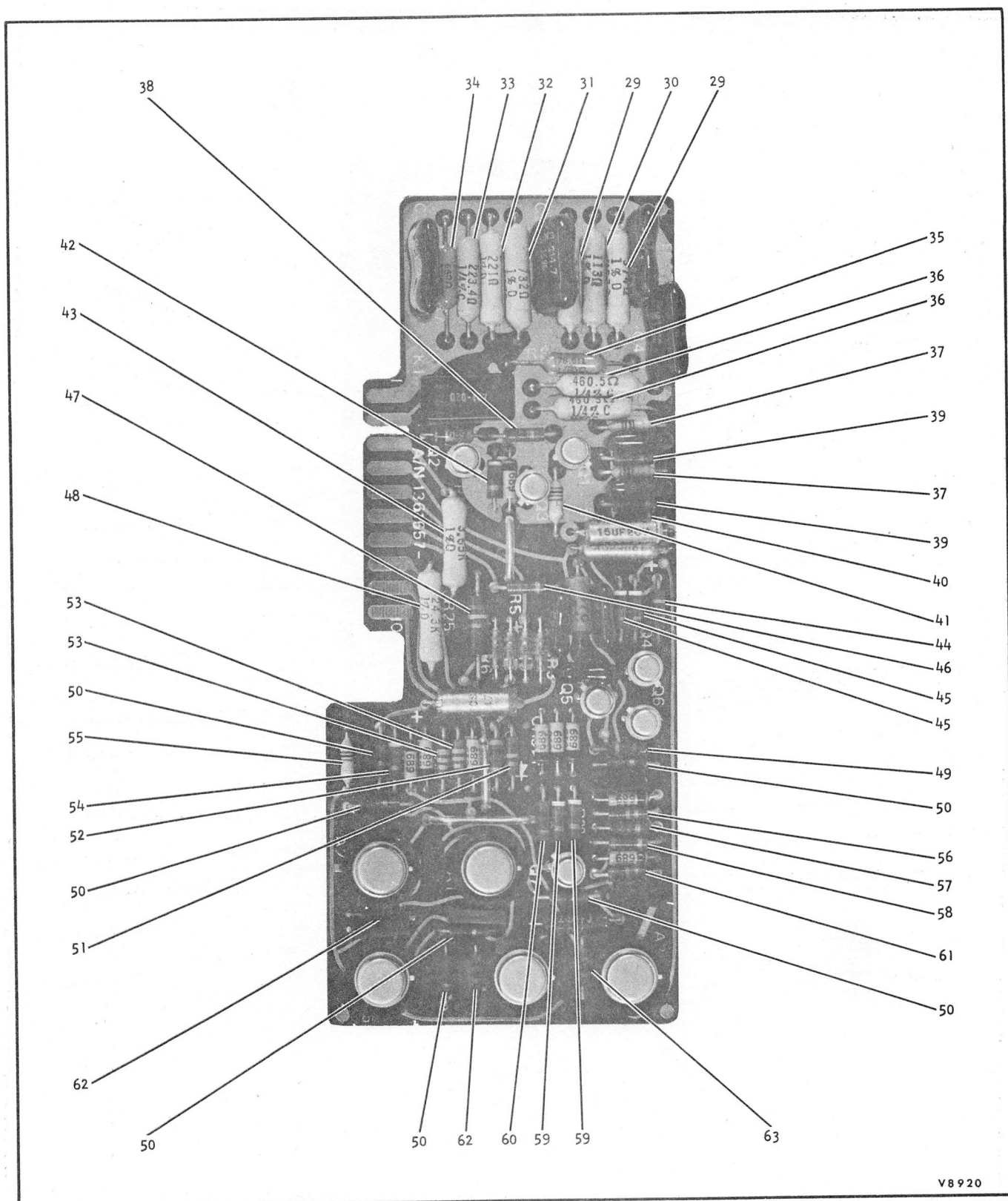


Figure 11-5. PWA Standards (625 HB-625 LB) (Board 19) (Sheet 1 of 2)



PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
5	1361657-02			PRINTED WIRING ASSEMBLY, Standards (625HB-625LB) (See Figure 2-3 For Next Higher Assembly)	Ref	B
-1	586-020	∴		. CIRCUIT, Integrated (A1).	1	B
-2	586-051	∴		. CIRCUIT, Integrated (A2,3).	2	B
-3	586-021	∴		. CIRCUIT, Integrated (A4,5).	2	B
-4	013-689			. DIODE (CR1-9,11-15)	14	B
-5	034-774			. CAPACITOR, Mica, 471.1PF, 500V, 1/2% (C1).	1	B
-6	034-770			. CAPACITOR, Mica, 214.7PF, 500V, 1/2% (C2).	1	B
-7	034-777			. CAPACITOR, Mica, 1071PF, 500V, 1/2% (C3).	1	B
-8	034-778			. CAPACITOR, Mica, 1345PF, 500V, 1/2% (C4).	1	B
-9	034-945			. CAPACITOR, Mica, 12PF, 500V, 5% (C5,6).	2	B
-10	037-068			. CAPACITOR, Tantalum, 15μF, 20V, 20% (C7,8).	2	B
-11	034-181			. CAPACITOR, Mica, 47PF, 500V, 5% (C9).	1	B
-12	034-212			. CAPACITOR, Mica, 330PF, 500V, 5% (C10).	1	B
-13	034-962			. CAPACITOR, Mica, 33PF, 500V, 5% (C11).	1	B
-14	037-085			. CAPACITOR, Tantalum, 47μF, 6V, 20% (C12).	1	B
-15	055-200			. CAPACITOR, Mylar, 0.0039μF, 50V, 3% (C13).	1	B
-16	035-828			. CAPACITOR, Mylar, 0.022μF, 50V, 5% (C14).	1	B
-17	035-843			. CAPACITOR, Mylar, 0.001μF, 50V, 10% (C15).	1	B
-18	055-144			. CAPACITOR, Mylar, 0.012μF, 50V, 5% (C16).	1	B
-19	035-817			. CAPACITOR, Mylar, 0.015μF, 50V, 5% (C17).	1	B
-20	030-883			. CAPACITOR, Ceramic, 0.15μF, 50V, 5% (C18).	1	B
-21	055-166			. CAPACITOR, Mylar, 0.001μF, 50V, 5% (C19,20,22).	3	B
-22	055-604			. CAPACITOR, Mylar, 0.0018μF, 50V, 5% (C21).	1	B
-23	035-815			. CAPACITOR, Mylar, 0.027μF, 50V, 5% (C23).	1	B
-24	020-467			. RELAY (K1).	1	B
-25	540-007	∴		. INDUCTOR, 470μF, 5% (L1).	1	B
-26	014-581			. TRANSISTOR (Q1).	1	B
-27	014-505			. TRANSISTOR (Q2,4,6).	3	B
-28	014-506			. TRANSISTOR (Q3,5,7).	3	B
-29	048-810			. RESISTOR, Metal Film, 374 Ohm, 1/2W, 1% (R1,3).	2	B
-30	048-962			. RESISTOR, Metal Film, 113 Ohm, 1/2W, 1% (R2).	1	B
-31	057-456			. RESISTOR, Metal Film, 732 Ohm, 1/2W, 1% (R4).	1	B
-32	048-457			. RESISTOR, Metal Film, 221 Ohm, 1/2W, 1% (R5).	1	B
-33	048-844			. RESISTOR, Metal Film, 223.4 Ohm, 1/4W, 1/4% (R6).	1	B
-34	048-850			. RESISTOR, Metal Film, 560.0 Ohm, 1/4W, 1/4%	1	B
-35	048-842			. RESISTOR, Metal Film, 178.6 Ohm, 1/4W, 1/4% (R8).	1	B
-36	048-848			. RESISTOR, Metal Film, 460.5 Ohm, 1/4W, 1/4% (R9,10).	2	B
-37	057-068			. RESISTOR, Metal Film, 68 Ohm, 1/4W, 2% (R11,14).	2	B
-38	041-414			. RESISTOR, Carbon Composition, 2200 Ohm, 1/4W, 5% (R12).	1	B
-39	041-647			. RESISTOR, Carbon Composition, 75 Ohm, 1/4W, 5% (R13,15).	2	B
-40	057-097			. RESISTOR, Metal Film, 1100 Ohm, 1/4W, 2% (R16).	1	B
-41	057-096			. RESISTOR, Metal Film, 1000 Ohm, 1/4W, 2% (R17).	1	B
-42	041-412			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, 5% (R18).	1	B
-43	057-238			. RESISTOR, Metal Film, 3650 Ohm, 1/2W, 1% (R19).	1	B
-44	041-750			. RESISTOR, Carbon Composition, 24000 Ohm, 1/4W, 5% (R20).	1	B
-45	041-532			. RESISTOR, Carbon Composition, 910 Ohm, 1/4W, 5% (R21,22).	2	B
-46	041-434			. RESISTOR, Carbon Composition, 1800 Ohm, 1/4W, 5% (R23).	1	B
-47	041-323			. RESISTOR, Carbon Composition, 270000 Ohm, 1/2W, 5% (R24).	1	B
-48	042-456			. RESISTOR, Metal Film, 24300 Ohm, 1/2W, 1% (R25).	1	B
-49	041-570			. RESISTOR, Carbon Composition, 2400 Ohm, 1/4W, 5% (R26).	1	B
-50	041-561			. RESISTOR, Carbon Composition, 5100 Ohm, 1/4W, 5% (R27,33,41,43,45,48)	6	B
-51	041-409			. RESISTOR, Carbon Composition, 15000 Ohm, 1/4W, 5% (R28).	1	B
-52	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, 5% (R29).	1	B
-53	041-549			. RESISTOR, Carbon Composition, 13000 Ohm, 1/4W, 5% (R30,31)	2	B
-54	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, 5% (R32).	1	B
-55	057-071			. RESISTOR, Metal Film, 91 Ohm, 1/4W, 2% (R34).	1	B
-56	041-573			. RESISTOR, Carbon Composition, 75000 Ohm, 1/4W, 5% (R35).	1	B

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
5-57	041-504			. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, 5% (R36) . .	1	B
-58	041-495			. RESISTOR, Carbon Composition, 8200 Ohm, 1/4W, 5% (R37) . .	1	B
-59	041-514			. RESISTOR, Carbon Composition, 9100 Ohm, 1/4W, 5% (R38, 39)	2	B
-60	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, 5% (R40) . .	1	B
-61	041-753			. RESISTOR, Carbon Composition, 62000 Ohm, 1/4W, 5% (R42) .	1	B
-62	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, 5% (R44, 47)	2	B
-63	041-437			. RESISTOR, Carbon Composition, 1600 Ohm, 1/4W, 5% (R46) . .	1	B
-64	280-174	∴		. SPACER, Integrated Circuit.	3	B
-65	280-173	∴		. SPACER, Integrated Circuit.	2	B
-66	1360036-01			. INSULATOR, Relay	1	B
-67	280-130	∴		. PAD, Transistor Mounting	7	B
-68	1361585-01			. PRINTED WIRING BOARD	1	B

11-27

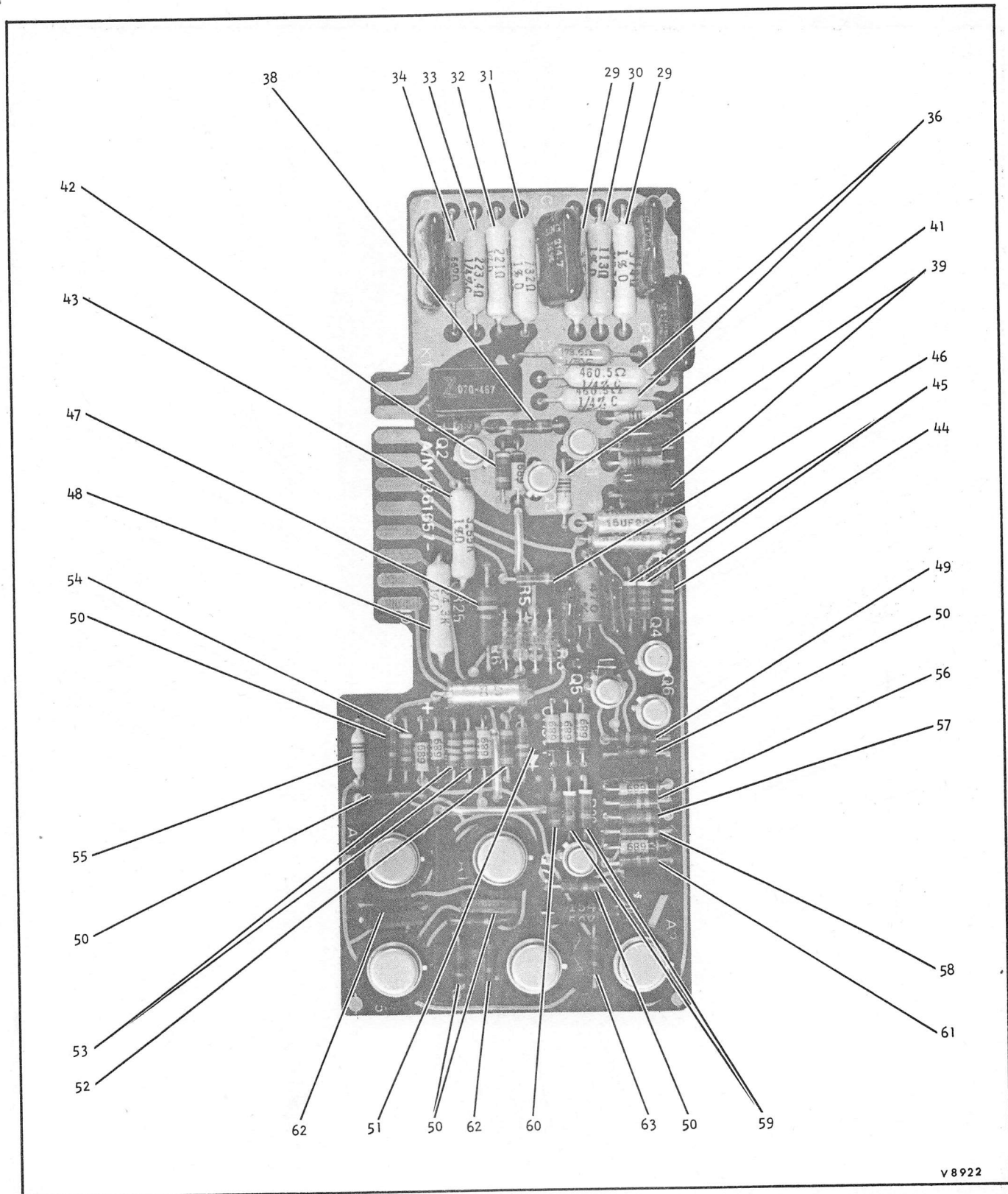


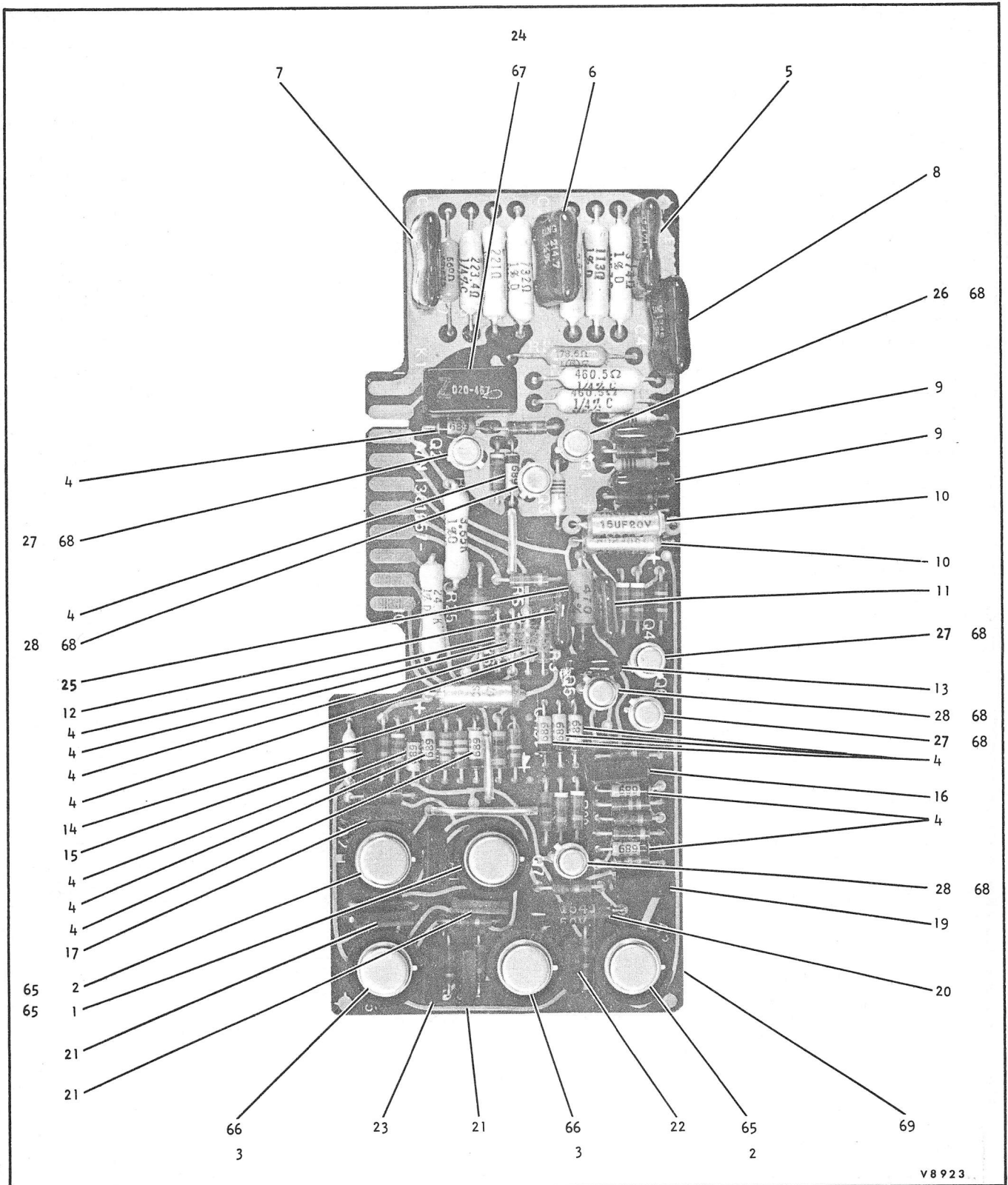
Figure 11-6. PWA Standards (819 HB-819 LB) (Board 19) (Sheet 2 of 2)

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
6	1361657-03			PRINTED WIRING ASSEMBLY, Standards (819HB-819LB) . . (See Figure 2-3 For Next Higher Assembly)	Ref	C
-1	586-020	✧		. CIRCUIT, Integrated (A1).	1	C
-2	586-051	✧		. CIRCUIT, Integrated (A2,3).	2	C
-3	586-021	✧		. CIRCUIT, Integrated (A4,5).	2	C
-4	013-689			. DIODE (CR1-15).	15	C
-5	034-774			. CAPACITOR, Mica, 471.1PF, 500V, 1/2% (C1).	1	C
-6	034-770			. CAPACITOR, Mica, 214.7PF, 500V, 1/2% (C2).	1	C
-7	034-777			. CAPACITOR, Mica, 1071PF, 500V, 1/2% (C3).	1	C
-8	034-778			. CAPACITOR, Mica, 1345PF, 500V, 1/2% (C4).	1	C
-9	034-945			. CAPACITOR, Mica, 12PF, 500V, 5% (C5,6).	2	C
-10	037-068			. CAPACITOR, Tantalum, 15μF, 20V, 20% (C7,8).	2	C
-11	034-181			. CAPACITOR, Mica, 47PF, 500V, 5% (C9).	1	C
-12	034-212			. CAPACITOR, Mica, 330PF, 500V, 5% (C10).	1	C
-13	034-962			. CAPACITOR, Mica, 33PF, 500V, 5% (C11).	1	C
-14	037-085			. CAPACITOR, Tantalum, 47μF, 6V, 20% (C12).	1	C
-15	055-200			. CAPACITOR, Mylar, 0.0039μF, 50V, 3% (C13).	1	C
-16	035-828			. CAPACITOR, Mylar, 0.022μF, 50V, 5% (C14).	1	C
-17	035-843			. CAPACITOR, Mylar, 0.0015μF, 50V, 10% (C15).	1	C
-18	055-144			. CAPACITOR, Mylar, 0.012μF, 50V, 5% (C16).	1	C
-19	035-817			. CAPACITOR, Mylar, 0.015μF, 50V, 5% (C17).	1	C
-20	030-883			. CAPACITOR, Ceramic, 0.15μF, 50V, 5% (C18).	1	C
-21	055-166			. CAPACITOR, Mylar, 0.001μF, 50V, 5% (C19,20,22).	3	C
-22	055-604			. CAPACITOR, Mylar, 0.0018μF, 50V, 5% (C21).	1	C
-23	035-815			. CAPACITOR, Mylar, 0.027μF, 50V, 5% (C23).	1	C
-24	020-467	✧		. RELAY (K1).	1	C
-25	540-007	✧		. INDUCTOR, 470μH, 5% (L1).	1	C
-26	014-581	✧		. TRANSISTOR (Q1).	1	C
-27	014-505	✧		. TRANSISTOR (Q2,4,6).	3	C
-28	014-506	✧		. TRANSISTOR (Q3,5,7).	3	C
-29	048-810			. RESISTOR, Metal Film, 374 Ohm, 1/2W, 1% (R1,3).	2	C
-30	048-962			. RESISTOR, Metal Film, 113 Ohm, 1/2W, 1% (R2).	1	C
-31	057-456			. RESISTOR, Metal Film, 732 Ohm, 1/2W, 1% (R4).	1	C
-32	048-457			. RESISTOR, Metal Film, 221 Ohm, 1/2W, 1% (R5).	1	C
-33	048-844			. RESISTOR, Metal Film, 223.4 Ohm, 1/4W, 1/4% (R6).	1	C
-34	048-850			. RESISTOR, Metal Film, 560.0 Ohm, 1/4W, 1/4% (R7).	1	C
-35	048-842			. RESISTOR, Metal Film, 178.6 Ohm, 1/4W, 1/4% (R8).	1	C
-36	048-848			. RESISTOR, Metal Film, 460.5 Ohm, 1/4W, 1/4% (R9,10).	2	C
-37	057-068			. RESISTOR, Metal Film, 68 Ohm, 1/4W, 2% (R11,14).	2	C
-38	041-414			. RESISTOR, Carbon Composition, 2200 Ohm, 1/4W, 5% (R12).	1	C
-39	041-647			. RESISTOR, Carbon Composition, 75 Ohm, 1/4W, 5% (R13,15).	2	C
-40	057-097			. RESISTOR, Metal Film, 1100 Ohm, 1/4W, 2% (R16).	1	C
-41	057-096			. RESISTOR, Metal Film, 1000 Ohm, 1/4W, 2% (R17).	1	C
-42	041-412			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, 5% (R18).	1	C
-43	057-238			. RESISTOR, Metal Film, 3650 Ohm, 1/2W, 1% (R19).	1	C
-44	041-750			. RESISTOR, Carbon Composition, 24000 Ohm, 1/4W, 5% (R20).	1	C
-45	041-532			. RESISTOR, Carbon Composition, 910 Ohm, 1/4W, ...	2	C
-46	041-434			. RESISTOR, Carbon Composition, 1800 Ohm, 1/4W, 5% (R23).	1	C
-47	041-323			. RESISTOR, Carbon Composition, 270000 Ohm, 1/2W, 5% (R24).	1	
-48	042-456			. RESISTOR, Metal Film, 2430 Ohm, 1/2W, 1% (R25).	1	C
-49	041-570			. RESISTOR, Carbon Composition, 2400 Ohm, 1/4W, 5% (R26).	1	C
-50	041-561			. RESISTOR, Carbon Composition, 5100 Ohm, 1/4W, 5% (R27,33,41,43,45,48).	6	C
-51	041-409			. RESISTOR, Carbon Composition, 15000 Ohm, 1/4W, 5% (R28).	1	C

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
6-52	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, 5% . (R29)	1	C
-53	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, . . 5% (R30,31)	2	C
-54	041-428			. RESISTOR, Carbon Composition, 470 Ohm, , 1/4W, . . 5% (R32)	1	C
-55	057-071			. RESISTOR, Metal Film, 91 Ohm, 1/4W, 2% (R34) . . .	1	C
-56	041-573			. RESISTOR, Carbon Composition, 75000 Ohm, 1/4W, . . 5% (R35)	1	C
-57	041-504			. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, . . .	1	C
-58	041-495			. RESISTOR, Carbon Composition, 8200 Ohm, 1/4W, . . . 5% (R37)	1	C
-59	041-413			. RESISTOR, Carbon Composition, 6800 Ohm, 1/4W, . . . 5% (R38,39)	2	C
-60	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, . . . 5% (R40)	1	C
-61	041-753			. RESISTOR, Carbon Composition, 62000 Ohm, 1/4W, . . . 5% (R42)	1	C
-62	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, . . . 5% (R44,47)	2	C
-63	041-437			. RESISTOR, Carbon Composition, 1600 Ohm, 1/4W, . . . 5% (R46)	1	C
-64	280-174	✱		. SPACER, Integrated Circuit.	3	C
-65	280-173	✱		. SPACER, Integrated Circuit.	2	C
-66	1360036-01			. INSULATOR, Relay	1	C
-67	280-130	✱		. PAD, Transistor Mounting	7	C
-68	1361585-01			. PRINTED WIRING BOARD	1	C



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Figure 11-7. PWA Standards (625 HB-405 LB) (Board 19) (Sheet 1 of 2)

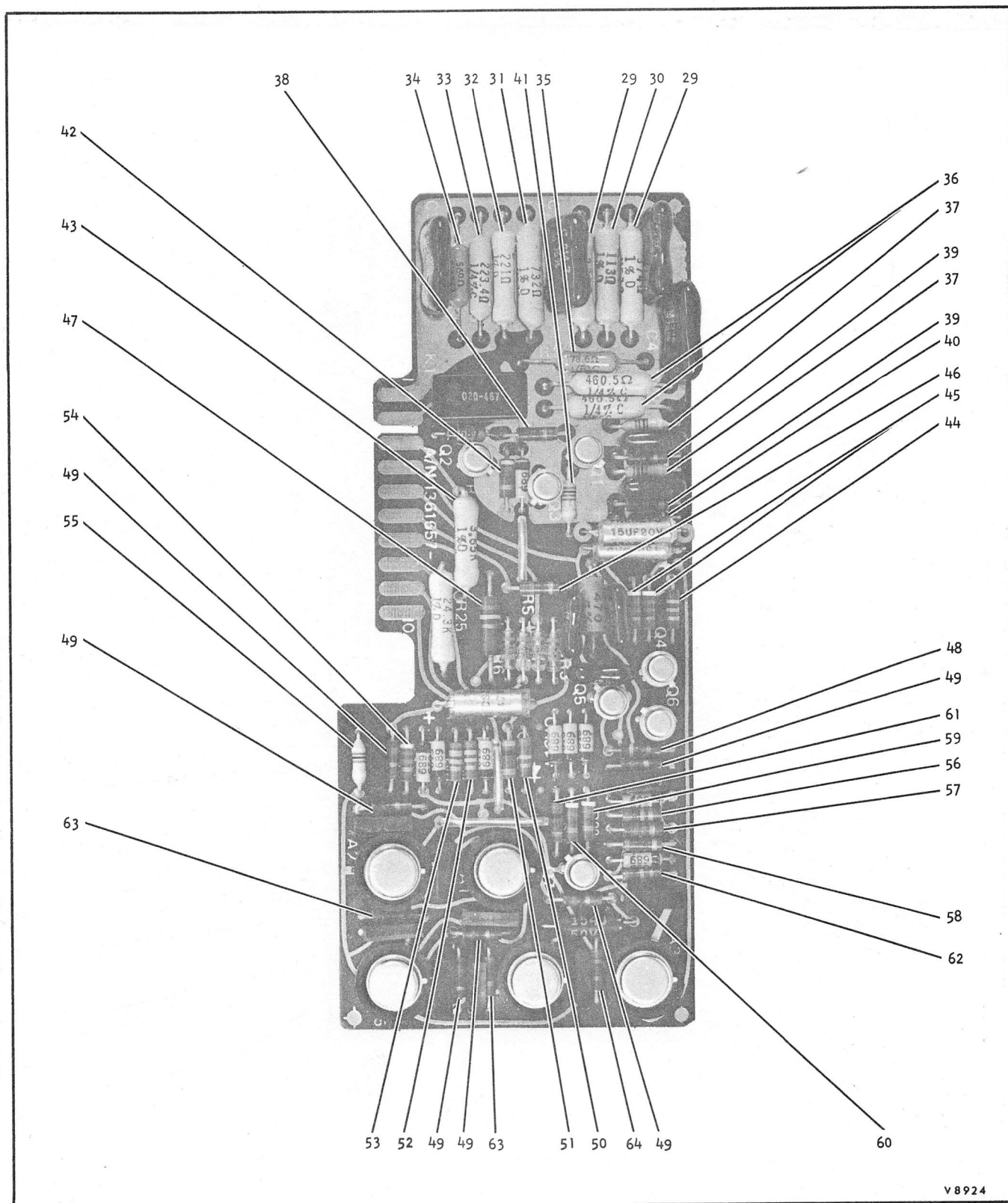


Figure 11-7. PWA Standards (625 HB-405 LB) (Board 19) (Sheet 2 of 2)

FIG. & INDEX NO.	PART NUMBER	★	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
7	1361657-04			PRINTED WIRING ASSEMBLY, Standards (625HB-405LB) . . (See Figure 2-3 For Next Higher Assembly)	Ref	D
-1	586-020	∴		. CIRCUIT, Integrated (A1).	1	D
-2	586-051	∴		. CIRCUIT, Integrated (A2,3).	2	D
-3	586-021	∴		. CIRCUIT, Integrated (A4,5).	2	D
-4	013-689			. DIODE (CR1-9, 11-15)	14	D
-5	034-773			. CAPACITOR, Mica, 335.2PF, 500V, 1/2% (C1).	1	D
-6	034-768			. CAPACITOR, Mica, 207.9PF, 500V, 1/2% (C2).	1	D
-7	034-777			. CAPACITOR, Mica, 1071PF, 500V, 1/2% (C3).	1	D
-8	034-778			. CAPACITOR, Mica, 1345PF, 500V, 1/2% (C4).	1	D
-9	034-945			. CAPACITOR, Mica, 12PF, 500V, 5% (C5,6)	2	D
-10	037-068			. CAPACITOR, Tantalum, 15μF, 20V, 20% (C7,8)	2	D
-11	034-181			. CAPACITOR, Mica, 47PF, 500V, 5% (C9)	1	D
-12	034-212			. CAPACITOR, Mica, 330PF, 500V, 5% (C10)	1	D
-13	034-962			. CAPACITOR, Mica, 33PF, 500V, 5% (C11)	1	D
-14	037-085			. CAPACITOR, Tantalum, 47μF, 6V, 20% (C12)	1	D
-15	055-200			. CAPACITOR, Mylar, 0.0039μF, 50V, 3% (C13)	1	D
-16	035-828			. CAPACITOR, Mylar, 0.022μF, 50V, 5% (C14)	1	D
-17	035-843			. CAPACITOR, Mylar, 0.0015μF, 50V, 10% (C15)	1	D
-18	055-144			. CAPACITOR, Mylar, 0.012μF, 50V, 5% (C16)	1	D
-19	035-817			. CAPACITOR, Mylar, 0.015μF, 50V, 5% (C17)	1	D
-20	030-883			. CAPACITOR, Ceramic, 0.15μF, 50V, 5% (C18)	1	D
-21	055-166			. CAPACITOR, Mylar, 0.001μF, 50V, 5% (C19,20,22)	3	D
-22	055-604			. CAPACITOR, Mylar, 0.0018μF, 50V, 5% (C21)	1	D
-23	035-815			. CAPACITOR, Mylar, 0.027μF, 50V, 5% (C23)	1	D
-24	020-467	∴		. RELAY (K1)	1	D
-25	540-007	∴		. INDUCTOR, 470μH, 5% (L1)	1	D
-26	014-581	∴		. TRANSISTOR (Q1)	1	D
-27	014-505	∴		. TRANSISTOR (Q2,4,6)	3	D
-28	014-506	∴		. TRANSISTOR (Q3,5,7)	3	D
-29	057-448			. RESISTOR, Metal Film, 555 Ohm, 1/2W, 1% (R1,3)	2	D
-30	057-978			. RESISTOR, Metal Film, 78.7 Ohm, 1/2W, 1% (R2)	1	D
-31	057-380			. RESISTOR, Metal Film, 634 Ohm, 1/2W, 1% (R4)	1	D
-32	047-890			. RESISTOR, Wirewound, 8.72 Ohm, 1/4W, 1/4% (R5)	1	D
-33	048-844			. RESISTOR, Metal Film, 223.4 Ohm, 1/4W, 1/4% (R6)	1	D
-34	048-850			. RESISTOR, Metal Film, 560.0 Ohm, 1/4W, 1/4% (R7)	1	D
-35	048-842			. RESISTOR, Metal Film, 178.6 Ohm, 1/4W, 1/4% (R8)	1	D
-36	048-848			. RESISTOR, Metal Film, 460.5 Ohm, 1/4W, 1/4% (R9,10)	2	D
-37	057-068			. RESISTOR, Metal Film, 68 Ohm, 1/4W, 2% (R11,14)	2	D
-38	041-414			. RESISTOR, Carbon Composition, 2200 Ohm, 1/4W, ... 5% (R12)	1	D
-39	041-647			. RESISTOR, Carbon Composition, 75 Ohm, 1/4W, 5% R13,15)	2	D
-40	057-097			. RESISTOR, Metal Film, 1100 Ohm, 1/4W, 2% (R16)	1	D
-41	057-096			. RESISTOR, Metal Film, 1000 Ohm, 1/4W, 2% (R17)	1	D
-42	041-412			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, ... 5% (R18)	1	D
-43	057-238			. RESISTOR, Metal Film, 3650 Ohm, 1/2W, 1% (R19)	1	D
-44	041-750			. RESISTOR, Carbon Composition, 24000 Ohm, 1/4W, ... 5% (R20)	1	D
-45	041-532			. RESISTOR, Carbon Composition, 910 Ohm, 1/4W, ... 5% (R21,22)	2	D
-46	041-434			. RESISTOR, Carbon Composition, 1800 Ohm, 1/4W, ... 5% (R23)	1	D
-47	041-323			. RESISTOR, Carbon Composition, 270000 Ohm, 1/2W, ... 5% (R24)	1	D
-48	041-570			. RESISTOR, Carbon Composition, 2400 Ohm, 1/4W, ... 5% (R26)	1	D
-49	041-561			. RESISTOR, Carbon Composition, 5100 Ohm, 1/4W, ... 5% (R27,33,41,43,45,48)	6	D
-50	041-409			. RESISTOR, Carbon Composition, 15000 Ohm, 1/4W, ... 5% (R28)	1	D

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
7-51	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, ... 5% (R29)	1	D
-52	041-549			. RESISTOR, Carbon Composition, 13000 Ohm, 1/4W, ... 5% (R30)	1	D
-53	041-508			. RESISTOR, Carbon Composition, 20000 Ohm, 1/4W, ... 5% (R31)	1	D
-54	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, ... 5% (R32)	1	D
-55	057-071			. RESISTOR, Metal Film, 91 Ohm, 1/4W, 2% (R34)	1	D
-56	041-573			. RESISTOR, Carbon Composition, 75000 Ohm, 1/4W, ... 5% (R35)	1	D
-57	041-504			. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, ... 5% (R36)	1	D
-58	041-495			. RESISTOR, Carbon Composition, 8200 Ohm, 1/4W, ... 5% (R37)	1	D
-59	041-514			. RESISTOR, Carbon Composition, 9100 Ohm, 1/4W, ... 5% (R38)	1	D
-60	041-482			. RESISTOR, Carbon Composition, 12000 Ohm, 1/4W, ... 5% (R40)	1	D
-61	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, ... 5% (R40)	1	D
-62	041-753			. RESISTOR, Carbon Composition, 62000 Ohm, 1/4W, ... 5% (R42)	1	D
-63	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, ... 5% (R44, 47)	2	D
-64	041-437			. RESISTOR, Carbon Composition, 1600 Ohm, 1/4W, ... 5% (R46)	1	D
-65	280-174	..		. SPACER, Integrated Circuit	3	D
-66	280-173	..		. SPACER, Integrated Circuit	2	D
-67	1360036-01			. INSULATOR, Relay	1	D
-68	280-130	..		. PAD, Transistor Mounting	7	D
-69	1361585-01			. PRINTED WIRING BOARD	1	D

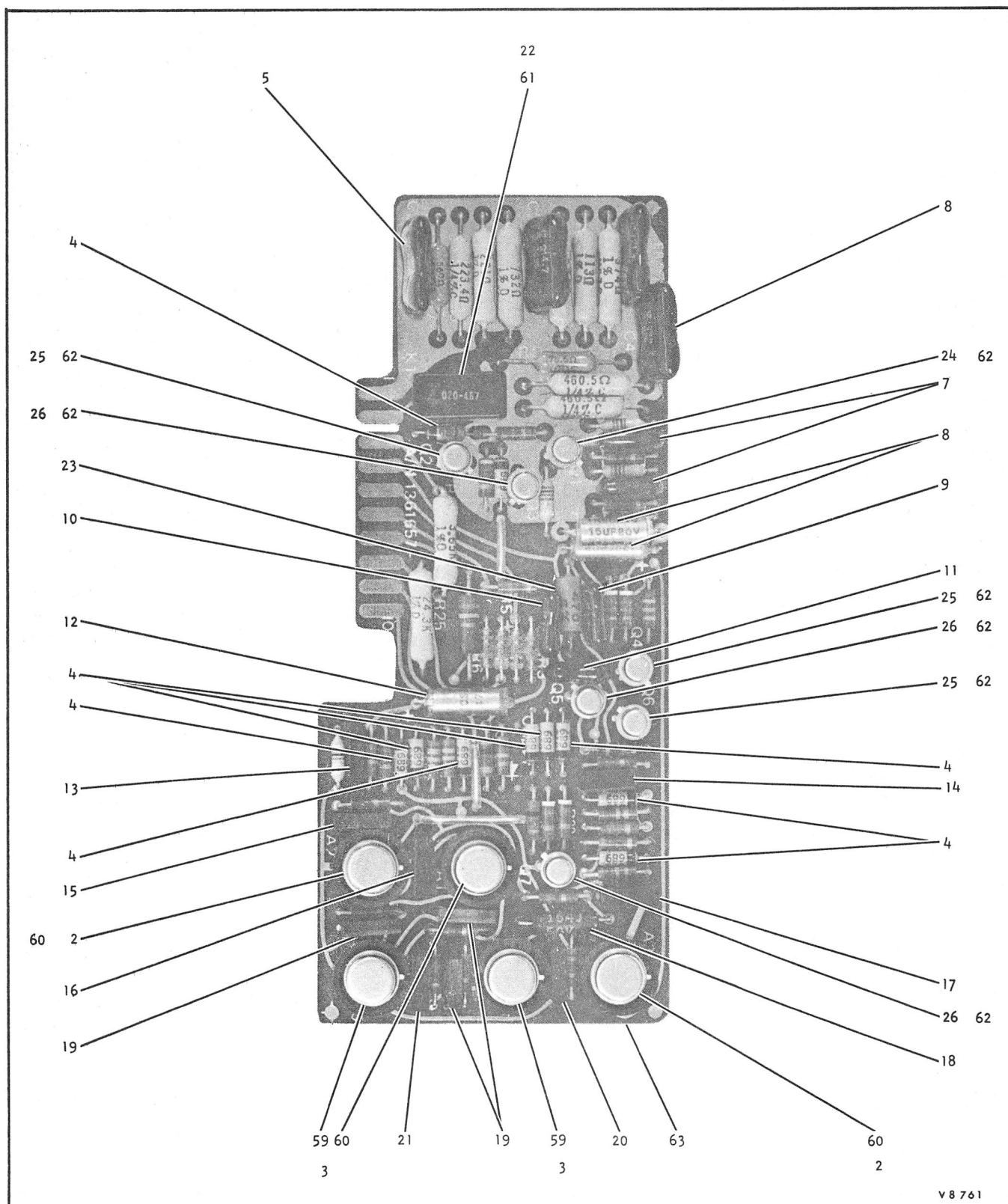


Figure 11-8. PWA Standards (625 HB-819 HB) (Board 19) (Sheet 1 of 2)

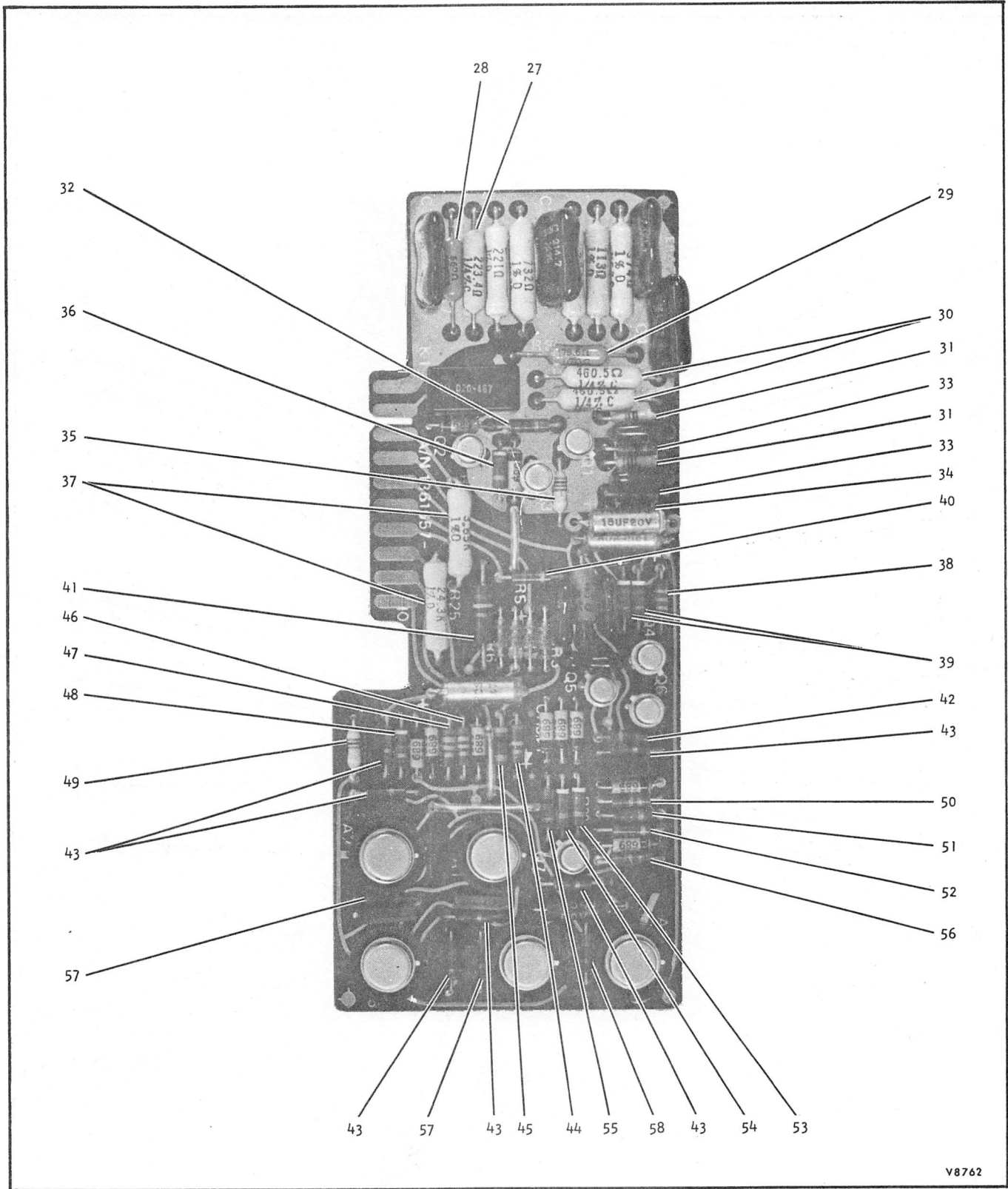


Figure 11-8. PWA Standards (625 HB-819 HB) (Board 19) (Sheet 2 of 2)

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
8	1361657-05			PRINTED WIRING ASSEMBLY, Standards (625HB-819HB) . . (See Figure 2-3 For Next Higher Assembly)	Ref	E
-1	586-020	..		. CIRCUIT, Integrated (A1)	1	E
-2	586-051	..		. CIRCUIT, Integrated (A2,3)	2	E
-3	586-021	..		. CIRCUIT, Integrated (A4,5)	2	E
-4	013-689			. DIODE (CR1,3-9,11-15)	13	E
-5	034-777			. CAPACITOR, Mica, 1071PF, 500V, 1/2% (C3)	1	E
-6	034-778			. CAPACITOR, Mica, 1345PF, 500V, 1/2% (C4)	1	E
-7	034-945			. CAPACITOR, Mica, 12PF, 500V, 5% (C5,6)	2	E
-8	037-068			. CAPACITOR, Tantalum, 15μF, 20V, 20% (C7,8)	2	E
-9	034-181			. CAPACITOR, Mica, 47PF, 500V, 5% (C9)	1	E
-10	034-212			. CAPACITOR, Mica, 330PF, 500V, 5% (C10)	1	E
-11	034-962			. CAPACITOR, Mica, 33PF, 500V, 5% (C11)	1	E
-12	037-085			. CAPACITOR, Tantalum, 47μF, 6V, 20% (C12)	1	E
-13	055-200			. CAPACITOR, Mylar, 0.0039μF, 50V, 3% (C13)	1	E
-14	035-828			. CAPACITOR, Mylar, 0.022μF, 50V, 5% (C14)	1	E
-15	035-843			. CAPACITOR, Mylar, 0.0015μF, 50V, 10% (C15)	1	E
-16	055-144			. CAPACITOR, Mylar, 0.012μF, 50V, 5% (C16)	1	E
-17	035-817			. CAPACITOR, Mylar, 0.015μF, 50V, 5% (C17)	1	E
-18	030-883			. CAPACITOR, Ceramic, 0.15μF, 50V, 5% (C18)	1	E
-19	055-166			. CAPACITOR, Mylar, 0.001μF, 50V, 5% (C19,20,22)	3	E
-20	055-604			. CAPACITOR, Mylar, 0.0018μF, 50V, 5% (C21)	1	E
-21	035-815			. CAPACITOR, Mylar, 0.027μF, 50V, 5% (C23)	1	E
-22	020-467	..		. RELAY (K1)	1	E
-23	540-007	..		. INDUCTOR, 470μH, 5% (L1)	1	E
-24	014-581	..		. TRANSISTOR (Q1)	1	E
-25	014-505	..		. TRANSISTOR (Q2,4,6)	3	E
-26	014-506	..		. TRANSISTOR (Q3,5,7)	3	E
-27	048-844			. RESISTOR, Metal Film, 223.4 Ohm, 1/4W, 1/4% (R6)	1	E
-28	048-850			. RESISTOR, Metal Film, 560.0 Ohm, 1/4W, 1/4% (R7)	1	E
-29	048-842			. RESISTOR, Metal Film, 178.6 Ohm, 1/4W, 1/4% (R8)	1	E
-30	048-848			. RESISTOR, Metal Film, 460.5 Ohm, 1/4W, 1/4% (R9,10)	2	E
-31	057-068			. RESISTOR, Metal Film, 68 Ohm, 1/4W, 2% (R11,14)	2	E
-32	041-414			. RESISTOR, Carbon Composition, 2200 Ohm, 1/4W, ... 5% (R12)	1	E
-33	041-647			. RESISTOR, Carbon Composition, 75 Ohm, 1/4W, 5% (R13,15)	2	E
-34	057-097			. RESISTOR, Metal Film, 1100 Ohm, 1/4W, 2% (R16)	1	E
-35	057-096			. RESISTOR, Metal Film, 1000 Ohm, 1/4W, 2% (R17)	1	E
-36	041-412			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, ... 5% (R18)	1	E
-37	057-238			. RESISTOR, Metal Film, 3650 Ohm, 1/2W, 1% (R19)	2	E
-38	041-750			. RESISTOR, Carbon Composition, 24000 Ohm, 1/4W, ... 5% (R20)	1	E
-39	041-532			. RESISTOR, Carbon Composition, 910 Ohm, 1/4W, ... 5% (R21,22)	2	E
-40	041-434			. RESISTOR, Carbon Composition, 1800 Ohm, 1/4W, ... 5% (R23)	1	E
-41	041-323			. RESISTOR, Carbon Composition, 270000 Ohm, 1/2W, ... 5% (R24)	1	E
-42	041-570			. RESISTOR, Carbon Composition, 2400 Ohm, 1/4W, ... 5% (R26)	1	E
-43	041-561			. RESISTOR, Carbon Composition, 5100 Ohm, 1/4W, ... 5% (R27,33,41,43,45,48)	6	E
-44	041-409			. RESISTOR, Carbon Composition, 15000 Ohm, 1/4W, ... 5% (R28)	1	E
-45	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, ... 5% (R29)	1	E
-46	041-549			. RESISTOR, Carbon Composition, 13000 Ohm, 1/4W, ... 5% (R30)	1	E
-47	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, ... 5% (R31)	1	E

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	★	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
8-48	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, ... 5% (R32)	1	E
-49	057-071			. RESISTOR, Metal Film, 91 Ohm, 1/4W, 2% (R34)	1	E
-50	041-573			. RESISTOR, Carbon Composition, 75000 Ohm, 1/4W, ... 5% (R35)	1	E
-51	041-504			. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, ... 5% (R36)	1	E
-52	041-495			. RESISTOR, Carbon Composition, 8200 Ohm, 1/4W, ... 5% (R37)	1	E
-53	041-514			. RESISTOR, Carbon Composition, 9100 Ohm, 1/4W, ... 5% (R38)	1	E
-54	041-413			. RESISTOR, Carbon Composition, 6800 Ohm, 1/4W, ... 5% (R39)	1	E
-55	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, ... 5% (R40)	1	E
-56	041-643			. RESISTOR, Carbon Composition, 62000 Ohm, 1/4W, ... 5% (R42)	1	E
-57	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, ... 5% (R44, 47)	2	E
-58	041-437			. RESISTOR, Carbon Composition, 1600 Ohm, 1/4W, ... 5% (R46)	1	E
-59	280-174	∴		. SPACER, Integrated Circuit	3	E
-60	280-173	∴		. SPACER, Integrated Circuit.	2	E
-61	1360036-01			. INSULATOR, Relay	1	E
-62	280-130			. PAD, Transistor Mounting	7	E
-63	1361585-01			. PRINTED WIRING BOARD	1	E

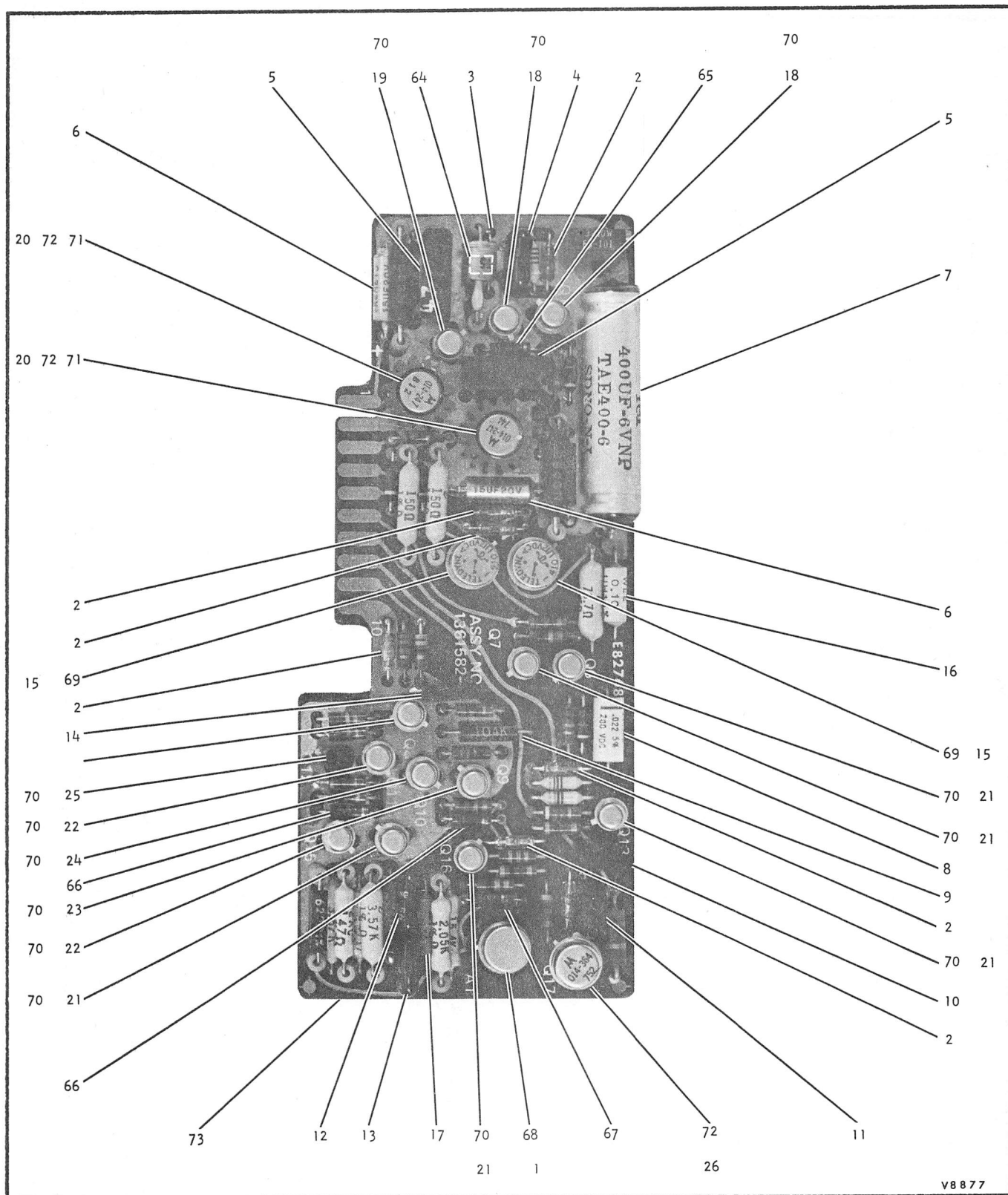


Figure 11-9. Input/Output Video (Board 18) (Sheet 1 of 2)

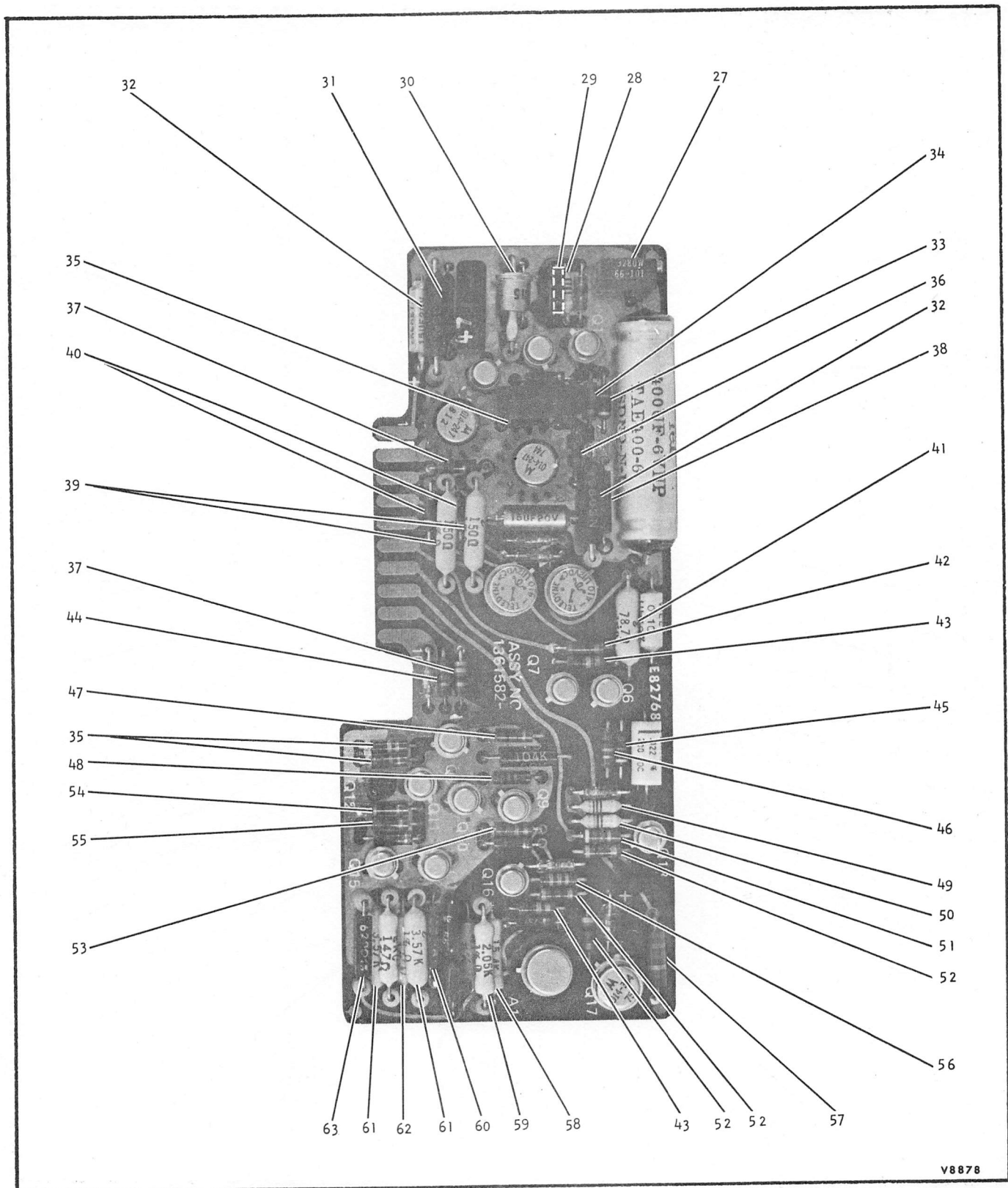


Figure 11-9. Input/Output Video (Board 18) (Sheet 2 of 2)

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
9	1361582-02			PRINTED WIRING ASSEMBLY, Input and Output Video . . . (See Figure 2-4 For Next Higher Assembly)	Ref	
-1	586-060	✱		. CIRCUIT, Integrated (A1)	1	
-2	013-689			. DIODE (CR1,3-8)	7	
-3	013-884	✱		. DIODE (CR2)	1	
-4	034-215			. CAPACITOR, Mica, 10PF, 500V, 5% (C1)	1	
-5	037-436			. CAPACITOR, Tantalum, 47 μ F, 25V, 10% (C2,5)	2	
-6	037-068			. CAPACITOR, Tantalum, 15 μ F, 20V, 20% (C3,6)	2	
-7	037-380			. CAPACITOR, Tantalum, 400 μ F, 6VNP, +75%-15% (C4)	1	
-8	055-581			. CAPACITOR, PYC, 0.022 μ F, 200V, 5% (C7)	1	
-9	030-576			. CAPACITOR, Ceramic, 1 μ F, 50V, 10% (C8)	1	
-10	037-462			. CAPACITOR, Tantalum, 2.2 μ F, 25V, 10% (C9)	1	
-11	037-522			. CAPACITOR, Tantalum, 4.7 μ F, 25V, 20% (C10)	1	
-12	034-182			. CAPACITOR, Mica, 56PF, 500V, 5% (C11)	1	
-13	034-240			. CAPACITOR, Mica, 220PF, 500V, 5% (C12)	1	
-14	035-828			. CAPACITOR, Mylar, 0.022 μ F, 50V, 5% (C13)	1	
-15	020-511	✱		. RELAY (K1,2)	2	
-16	051-281	✱		. INDUCTOR (L1)	1	
-17	540-007	✱		. INDUCTOR (L2)	1	
-18	014-581	✱		. TRANSISTOR (Q1,2)	2	
-19	014-387	✱		. TRANSISTOR (Q3)	1	
-20	014-247	✱		. TRANSISTOR (Q4,5)	2	
-21	014-506	✱		. TRANSISTOR (Q6,7,13,14,16)	5	
-22	014-505	✱		. TRANSISTOR (Q8,11,15)	3	
-23	014-617			. TRANSISTOR (Q9)	1	
-24	014-383	✱		. TRANSISTOR (Q10)	1	
-25	014-949			. TRANSISTOR (Q12)	1	
-26	014-364	✱		. TRANSISTOR (Q17)	1	
-27	058-318			. RESISTOR, Variable, 100 Ohm, 1W, 5% (R1)	1	
-28	057-074			. RESISTOR, Metal Film, 120 Ohm, 1/4W, 2% (R2)	1	
-29	057-089			. RESISTOR, Metal Film, 510 Ohm, 1/4W, 2% (R3)	1	
-30	041-437			. RESISTOR, Carbon Composition, 1600 Ohm, 1/4W, ... 5% (R4)	1	
-31	047-891			. RESISTOR, Wirewound, 560 Ohm, 1W, 5% (R5)	1	
-32	059-225			. RESISTOR, Wirewound, 90 Ohm, 3W, 3% (R6,13)	2	
-33	057-105			. RESISTOR, Metal Film, 2400 Ohm, 1/4W, 2% (R7)	1	
-34	041-434			. RESISTOR, Carbon Composition, 1800 Ohm, 1/4W, ... 5% (R8)	1	
-35	041-482			. RESISTOR, Carbon Composition, 12000 Ohm, 1/4W, ... 5% (R9,27,28)	3	
-36	041-497			. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, ... 5% (R10)	1	
-37	041-651			. RESISTOR, Carbon Composition, 33 Ohm, 1/4W, ... 5% (R11,21)	2	
-38	047-859			. RESISTOR, Wirewound, 470 Ohm, 1W, 5% (R12)	1	
-39	048-625			. RESISTOR, Metal Film, 150 Ohm, 1/4W, 1% (R14,16)	2	
-40	057-076			. RESISTOR, Metal Film, 150 Ohm, 1/4W, 2% (R15,17)	2	
-41	057-978			. RESISTOR, Metal Film, 78.7 Ohm, 1/4W, 1% (R18)	1	
-42	041-538			. RESISTOR, Carbon Composition, 6200 Ohm, 1/4W, ... 5% (R19)	1	
-43	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, ... 5% (R20,38)	2	
-44	041-738			. RESISTOR, Carbon Composition, 160 Ohm, 1/4W, ... 5% (R22)	1	
-45	057-120			. RESISTOR, Metal Film, 10000 Ohm, 1/4W, 2% (R23)	1	
-46	041-508			. RESISTOR, Carbon Composition, 20000 Ohm, 1/4W, ... 5% (R24)	1	
-47	041-560			. RESISTOR, Carbon Composition, 2000 Ohm, 1/4W, ... 5% (R25)	1	
-48	041-483			. RESISTOR, Carbon Composition, 27000 Ohm, 1/4W, ... 5% (R26)	1	
-49	057-115			. RESISTOR, Metal Film, 6200 Ohm, 1/4W, 2% (R29)	1	

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
9-50	057-108			. RESISTOR, Metal Film, 3300 Ohm, 1/4W, 2% (R30) . . .	1	
-51	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, ...	1	
				5% (R31)		
-52	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, . . .	3	
				5% (R32, 37, 40)		
-53	041-436			. RESISTOR, Carbon Composition, 18000 Ohm, 1/4W, . . .	1	
				5% (R33)		
-54	041-781			. RESISTOR, Carbon Composition, 3 Megohm, 1/4W, . . .	1	
				5% (R34)		
-55	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, ...	1	
				5% (R35)		
-56	041-750			. RESISTOR, Carbon Composition, 24000 Ohm, 1/4W, . . .	1	
				5% (R36) -57		
-57	041-291			. RESISTOR, Carbon Composition, 160 Ohm, 1/2W, ...	1	
				5% (R39)		
-58	057-981			. RESISTOR, Metal Film, 15400 Ohm, 1/4W, 1% (R41) . . .	1	
-59	057-980			. RESISTOR, Metal Film, 2050 Ohm, 1/4W, 1% (R42) . . .	1	
-60	043-974			. RESISTOR, Wirewound, 750 Ohm, 1W, 1% (R43)	1	
-61	057-759			. RESISTOR, Metal Film, 3570 Ohm, 1/4W, 1% (R44, 47) . .	2	
-62	057-979			. RESISTOR, Metal Film, 147 Ohm, 1/4W, 1% (R45, 46) . .	2	
-63	043-682			. RESISTOR, Wirewound, 620 Ohm, 1W, 1% (R48)	1	
-64	013-982	..		. DIODE (VR1)	1	
-65	013-358	..		. DIODE (VR2)	1	
-66	013-224	..		. DIODE (VR3, 4)	2	
-67	013-257	..		. DIODE (VR5)	1	
-68	280-173	..		. SPACER, Integrated Circuit	1	
-69	014-847	..		. PAD, Relay Mounting	2	
-70	014-715	..		. PAD, Transistor Mounting	14	
-71	014-070	..		. HEAT SINK	2	
-72	280-998	..		. PAD, Transistor Mounting	3	
-73	1361583-02			. PRINTED WIRING BOARD	1	

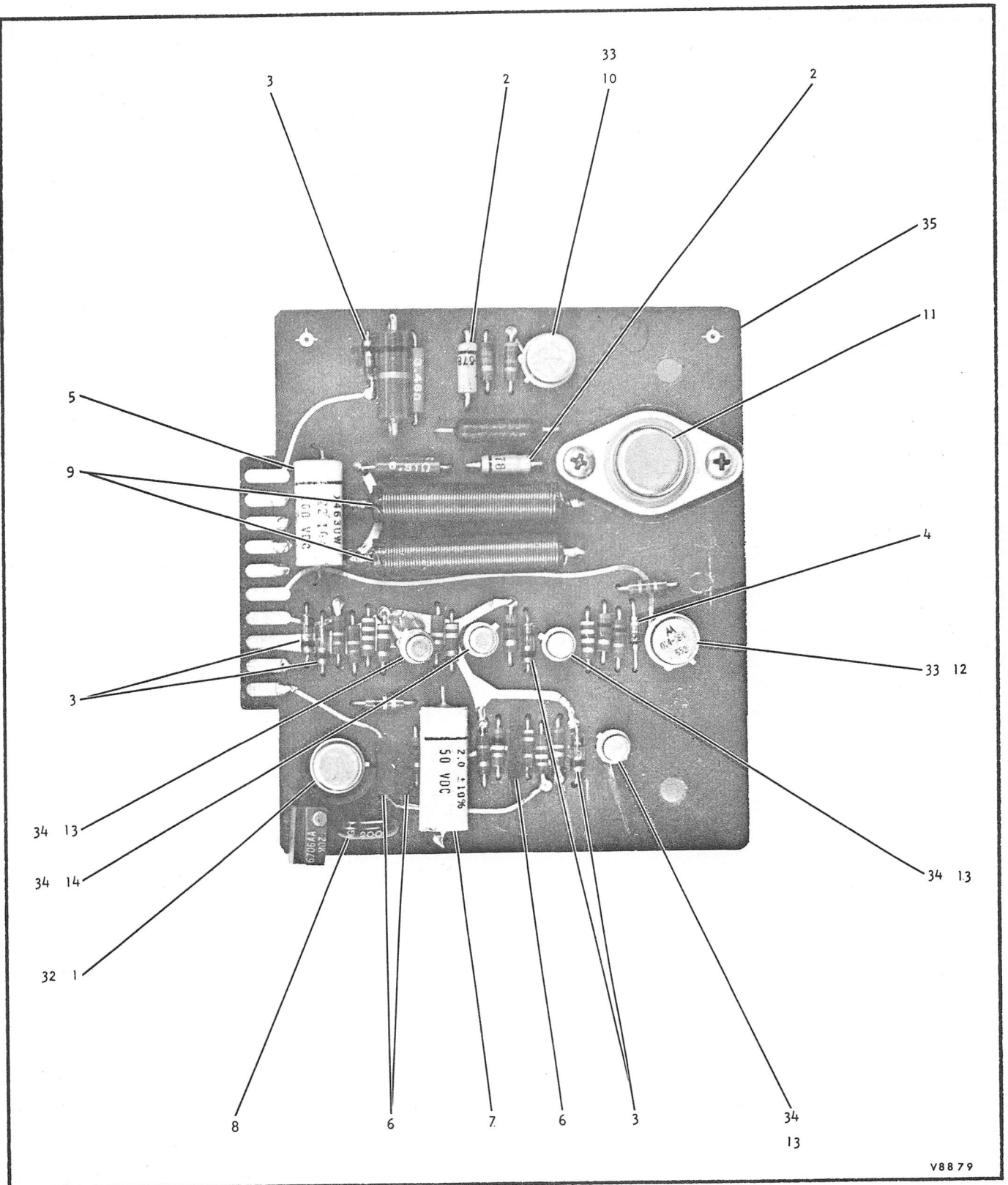


Figure 11-10. Supply Motor and Brake (Board 27) (Sheet 1 of 2)

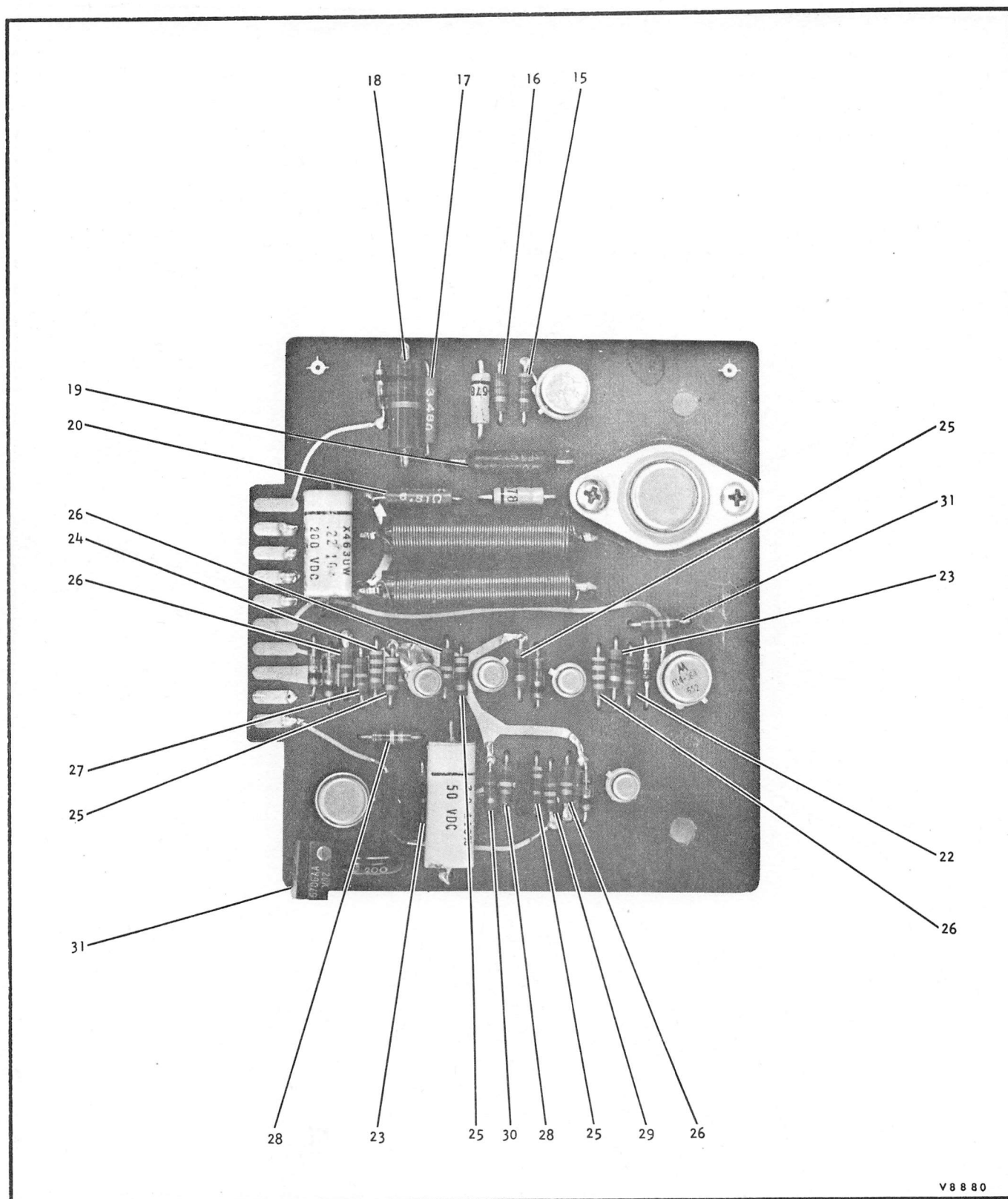


Figure 11-10. Supply Motor and Brake (Board 27) (Sheet 2 of 2)

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
10	1363796-01			PRINTED WIRING ASSEMBLY, Supply Motor and Brake . . . Ref		
-1	586-024	∴		Driver (See Figure 2-5 For Next Higher Assembly)		
-2	013-678			. CIRCUIT, Integrated (A1)	1	
-3	013-689			. DIODE (CR1,3)	2	
-4	013-599	∴		. DIODE (CR2,5-8)	5	
-5	055-607			. DIODE (CR4)	1	
-6	035-840			. CAPACITOR, PYC, 0.22μF, 100V, 10% (C1)	1	
-7	055-609			. CAPACITOR, Mylar, 0.01μF, 50V, 10% (C2,4,5)	3	
-8	034-286			. CAPACITOR, PYC, 2μF, 50V, 10% (C3)	1	
-9	051-634			. CAPACITOR, Mica, 200PF, 500V, 5% (C6)	1	
-10	014-678	∴		. INDUCTOR (L1,2)	2	
-11	014-947	∴		. TRANSISTOR (Q1)	1	
	471-011			. TRANSISTOR (2N3766) (Q2)	1	
	501-008			. SCREW, Machine, Pan Head, 4-40 x 5/16 Lg (AP)	2	
	496-004			. WASHER, Flat, #4 (AP)	2	
-12	014-364	∴		. NUT, Assembled Washer, 4-40 (AP)	2	
-13	014-506	∴		. TRANSISTOR (Q3)	1	
-14	014-505	∴		. TRANSISTOR (Q4,6,7)	3	
-15	041-505	∴		. TRANSISTOR (Q5)	1	
				. RESISTOR, Carbon Composition, 620 Ohm, 1/4W, ...	1	
-16	041-504			5% (R1)		
				. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, ...	1	
-17	059-228			5% (R2)		
-18	059-230			. RESISTOR, Wirewound, 3.6 Ohm, 1W, 3% (R3)	1	
-19	059-222			. RESISTOR, Wirewound, 2000 Ohm, 1W, 3% (R4)	1	
-20	059-229			. RESISTOR, Wirewound, 2.5 Ohm, 3W, 3% (R5)	1	
-21	041-738			. RESISTOR, Wirewound, 6.8 Ohm, 1W, 3% (R6)	1	
				. RESISTOR, Carbon Composition, 160 Ohm, 1/4W, ...	1	
-22	041-560			5% (R7)		
				. RESISTOR, Carbon Composition, 2000 Ohm, 1/4W, ...	1	
-23	041-410			5% (R8)		
				. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, ...	3	
-24	041-438			5% (R9,11,24)		
				. RESISTOR, Carbon Composition, 33000 Ohm, 1/4W, ...	2	
-25	041-407			5% (R10,17)		
				. RESISTOR, Carbon Composition, 3300 Ohm, 1/4W, ...	3	
-26	041-409			5% (R12,14,21)		
				. RESISTOR, Carbon Composition, 15000 Ohm, 1/4W, ...	3	
-27	041-408			5% (R13,16,19)		
				. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, ...	1	
-28	041-394			5% (R15)		
				. RESISTOR, Carbon Composition, 100000 Ohm, 1/4W, ...	2	
-29	041-519			5% (R18,22)		
				. RESISTOR, Carbon Composition, 56000 Ohm, 1/4W, ...	1	
-30	041-507			5% (R20)		
				. RESISTOR, Carbon Composition, 5600 Ohm, 1/4W, ...	1	
-31	058-330			5% (R23)		
-32	280-173	∴		. RESISTOR, Variable, 20000 Ohm, 1W, 5% (R25)	1	
-33	280-998	∴		. SPACER, Integrated Circuit.	1	
-34	280-130	∴		. PAD, Transistor Mounting	2	
-35	1363797-01			. PAD, Transistor Mounting	4	
				. PRINTED WIRING BOARD	1	

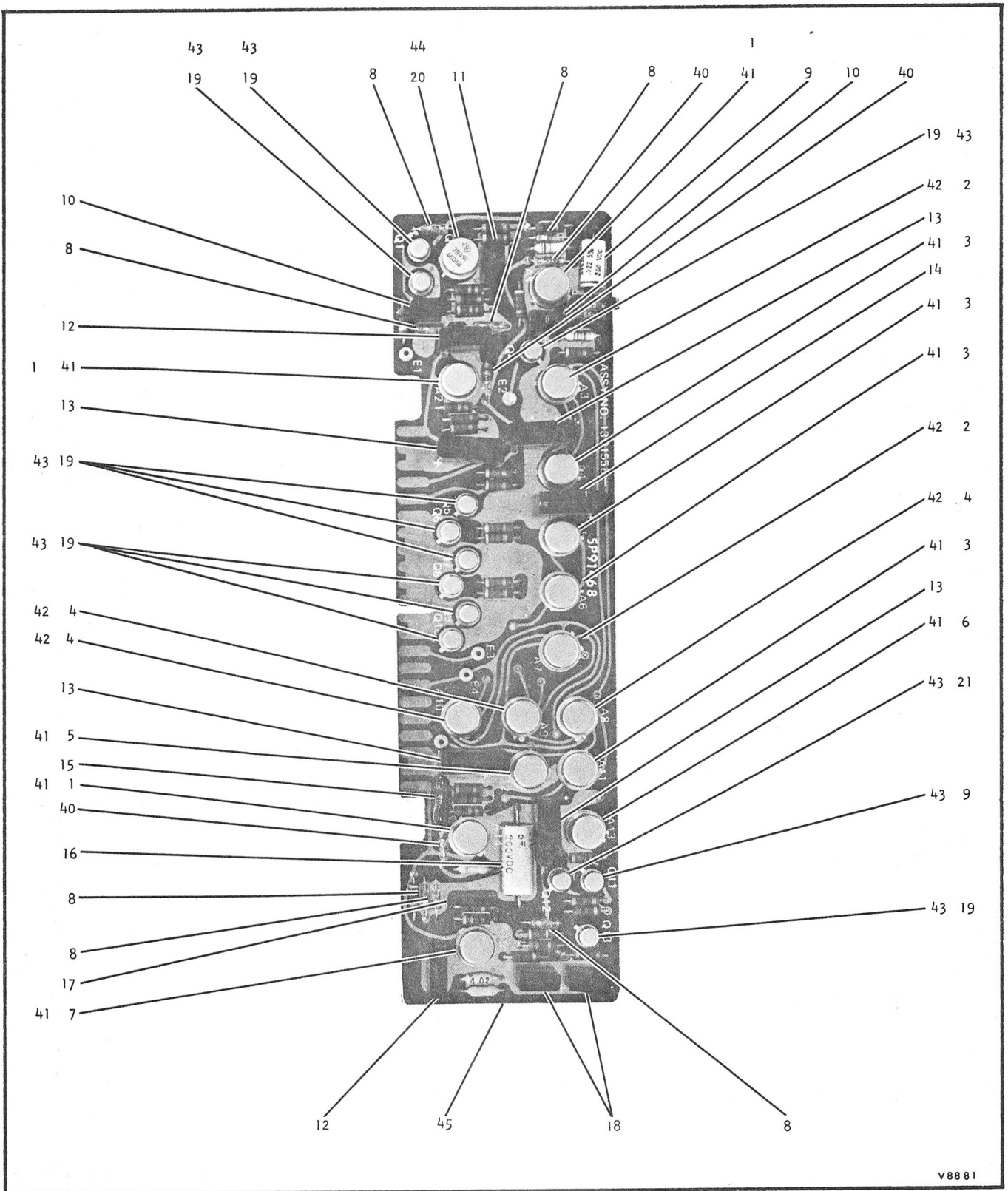


Figure 11-11. MDA Driver (Board 16) (Sheet 1 of 2)

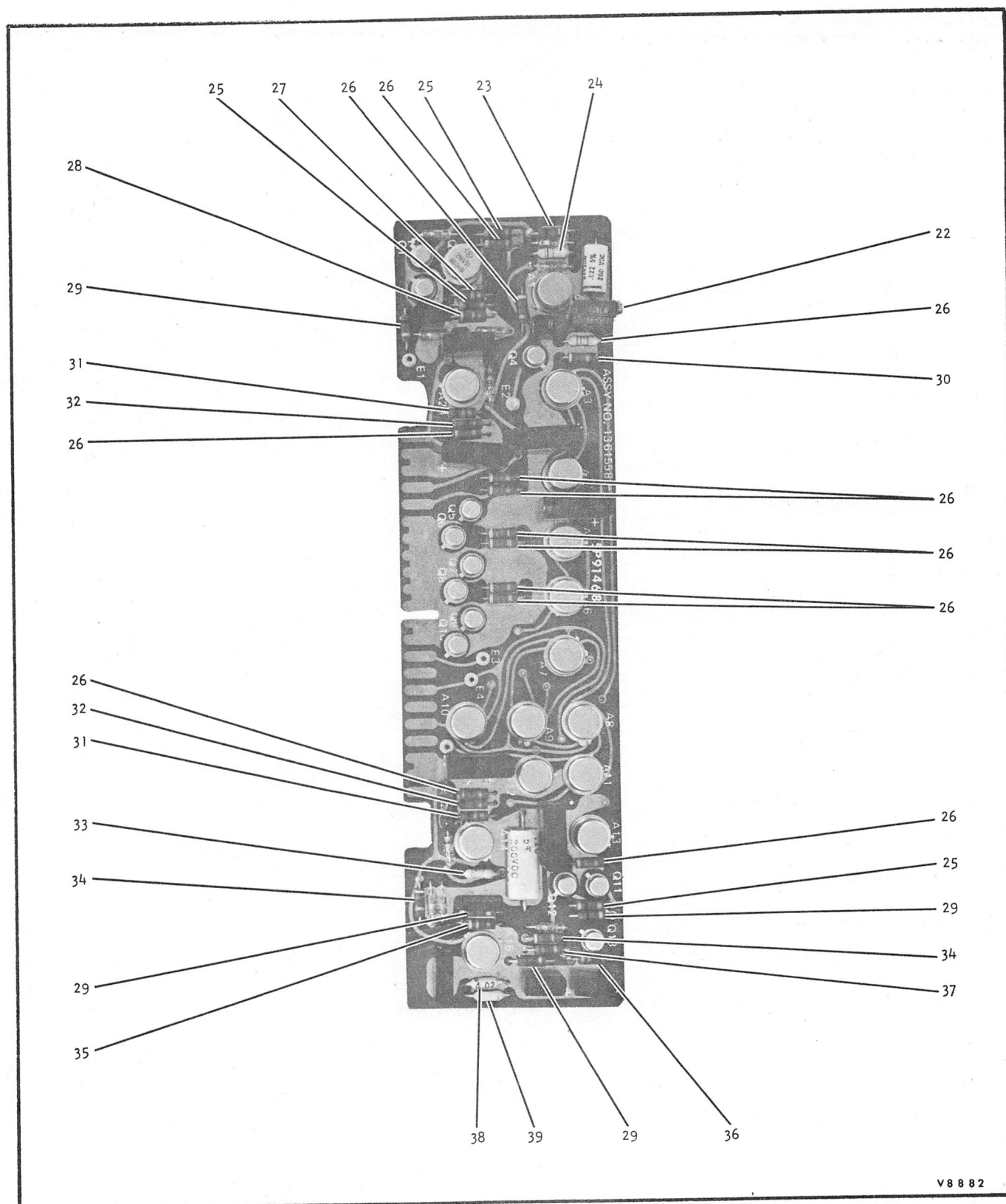
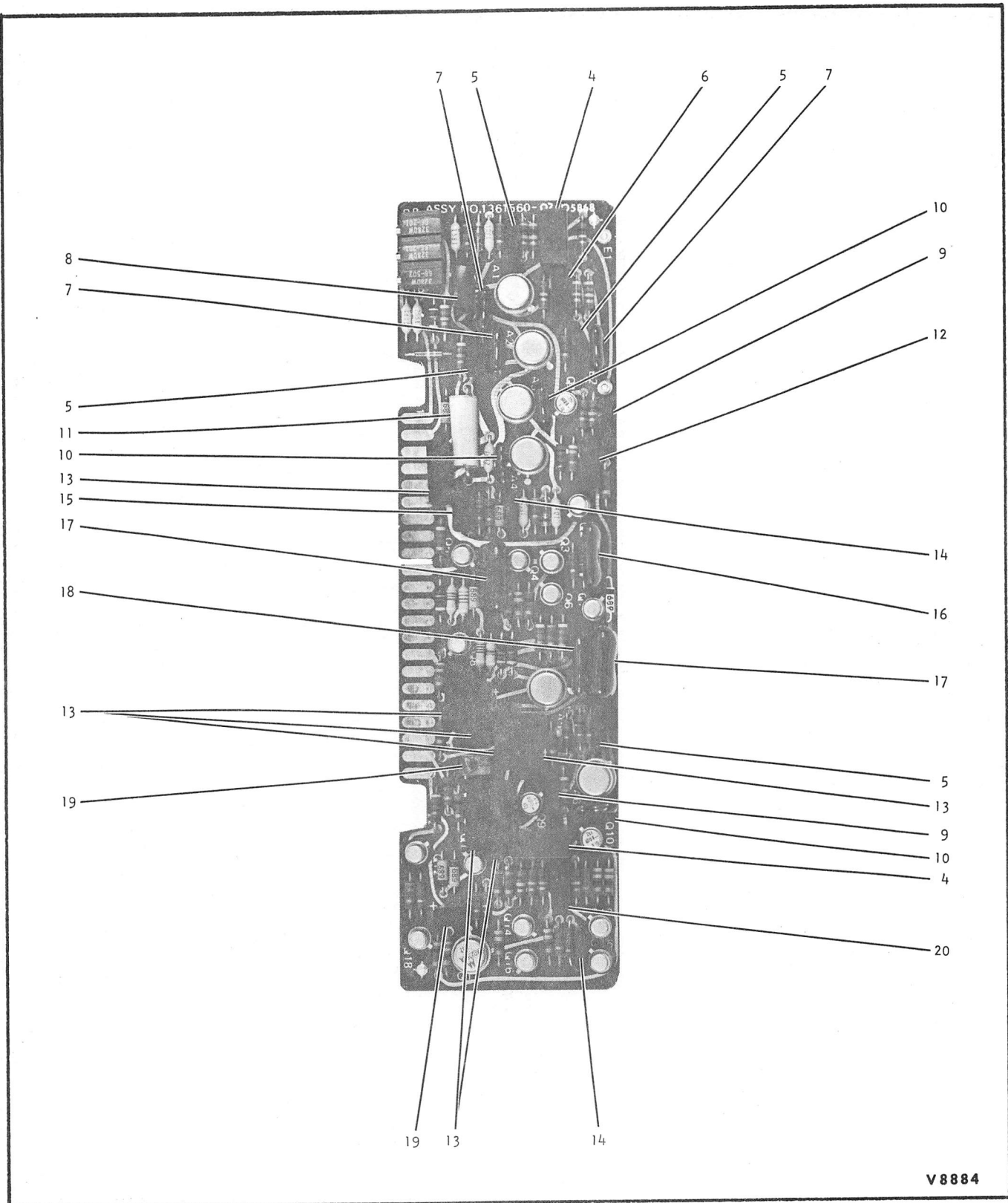


Figure 11-11. MDA Driver (Board 16) (Sheet 2 of 2)

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	★	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
11	1361558-01			PRINTED WIRING ASSEMBLY, Drum MDA Driver (See . . . Figure 2-6 For Next Higher Assembly)	Ref	
-1	586-060	∴		. CIRCUIT, Integrated (A1,2,14)	3	
-2	586-051	∴		. CIRCUIT, Integrated (A3,7)	2	
-3	586-021	∴		. CIRCUIT, Integrated (A4,6,11)	4	
-4	586-052	∴		. CIRCUIT, Integrated (A8-10)	3	
-5	586-022	∴		. CIRCUIT, Integrated (A12)	1	
-6	586-019	∴		. CIRCUIT, Integrated (A13)	1	
-7	586-024	∴		. CIRCUIT, Integrated (A15)	1	
-8	013-689			. DIODE (CR1-7)	7	
-9	055-581			. CAPACITOR, PYC, 0.022μF, 200V, 5% (C1)	1	
-10	037-519			. CAPACITOR, Tantalum, 1μF, 35V, 20% (C2,4)	2	
-11	037-476			. CAPACITOR, Tantalum, 10μF, 25V, 10% (C3)	1	
-12	035-883			. CAPACITOR, Mylar Foil, 0.068μF, 50V, 5% (C5,16)	2	
-13	037-436			. CAPACITOR, Tantalum, 47μF, 25V, 10% (C6,7,10,11)	4	
-14	037-426			. CAPACITOR, Tantalum, 82μF, 15V, 10% (C8)	1	
-15	056-163			. CAPACITOR, Mica, 470PF, 500V, 5% (C9)	1	
-16	055-582			. CAPACITOR, PYC, 0.1μF, 200V, 5% (C12)	1	
-17	035-841			. CAPACITOR, Mylar Foil, 0.0047μF, 50V, 10% (C13)	1	
-18	037-439			. CAPACITOR, Tantalum, 22μF, 15V, 10% (C14,15)	2	
-19	014-506	∴		. TRANSISTOR (Q1,3-11,13)	11	
-20	014-057	∴		. TRANSISTOR (2N491) (Q2).	1	
-21	014-505	∴		. TRANSISTOR (Q12)	1	
-22	058-321			. RESISTOR, Variable, 5000 Ohm, 1W, 5% (R1)	1	
-23	041-419			. RESISTOR, Carbon Composition, 100 Ohm, 1/4W, 5% (R2)	1	
-24	057-144			. RESISTOR, Metal Film, 100000 Ohm, 1/4W, 2% (R3)	1	
-25	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, ... 5% (R4,8,28)	3	
-26	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, ... 5% (R5,6,12,15-22,25)	12	
-27	041-543			. RESISTOR, Carbon Composition, 82000 Ohm, 1/4W, ... 5% (R7)	1	
-28	041-411			. RESISTOR, Carbon Composition, 47000 Ohm, 1/4W, ... 5% (R9)	1	
-29	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, ... 5% (R10,29,30,35)	4	
-30	057-121			. RESISTOR, Metal Film, 11000 Ohm, 1/4W, 2% (R11)	1	
-31	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, ... 5% (R13,24)	2	
-32	041-554			. RESISTOR, Carbon Composition, 51 Ohm, 1/4W, ... 5% (R14,23)	2	
-33	057-970			. RESISTOR, Metal Film, 18200 Ohm, 1/10W, 1% (R26)	1	
-34	041-412			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, ... 5% (R27,33)	2	
-35	041-743			. RESISTOR, Carbon Composition, 430 Ohm, 1/4W, ... 5% (R31)	1	
-36	041-427			. RESISTOR, Carbon Composition, 330 Ohm, 1/4W, ... 5% (R32)	1	
-37	041-413			. RESISTOR, Carbon Composition, 6800 Ohm, 1/4W, ... 5% (R34)	1	
-38	057-965			. RESISTOR, Metal Film, 4020 Ohm, 1/10W, 1% (R36)	1	
-39	057-967			. RESISTOR, Metal Film, 4990 Ohm, 1/10W, 1% (R37)	1	
-40	013-257	∴		. DIODE (VR1-3)	3	
-41	586-160	∴		. PAD, Mounting, Integrated Circuit	10	
-42	586-149	∴		. PAD, Mounting, Integrated Circuit	5	
-43	280-100	∴		. PAD, Transistor Mounting	12	
-44	280-998	∴		. PAD, Transistor Mounting	1	
-45	1361559-02			. PRINTED WIRING BOARD	1	



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Figure 11-12. Drum Servo (Board 15) (Sheet 2 of 4)

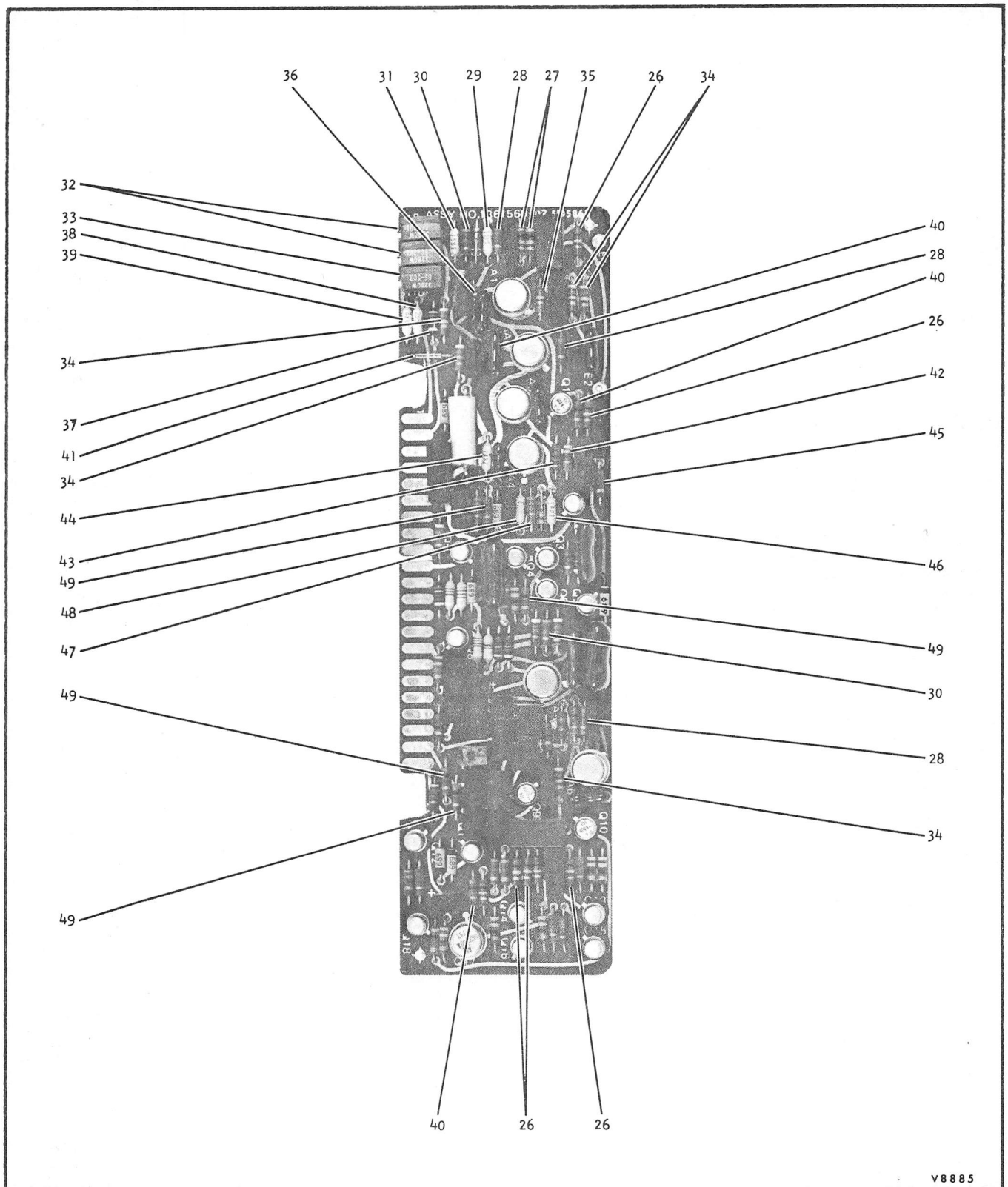
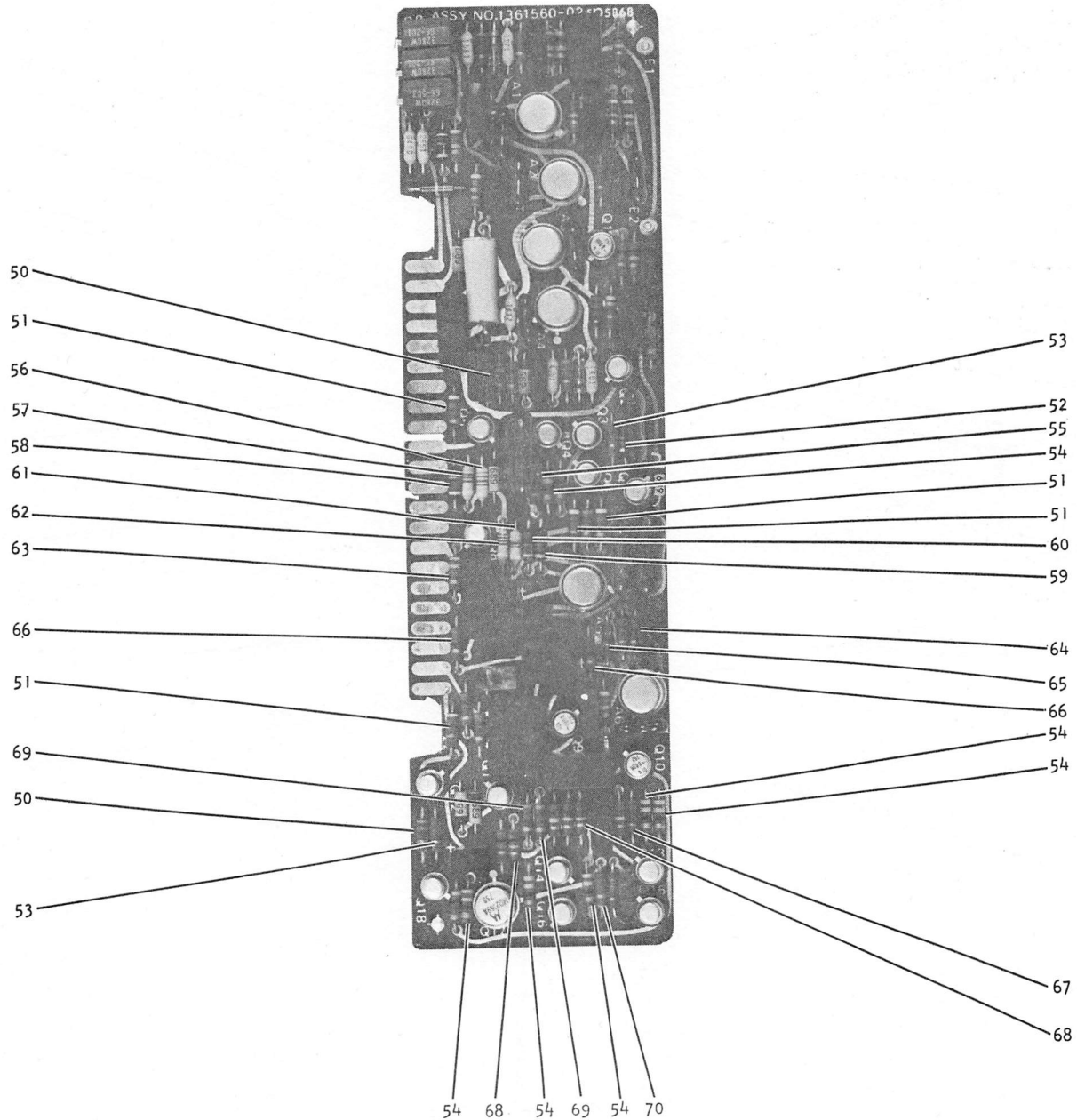


Figure 11-12. Drum Servo (Board 15) (Sheet 3 of 4)



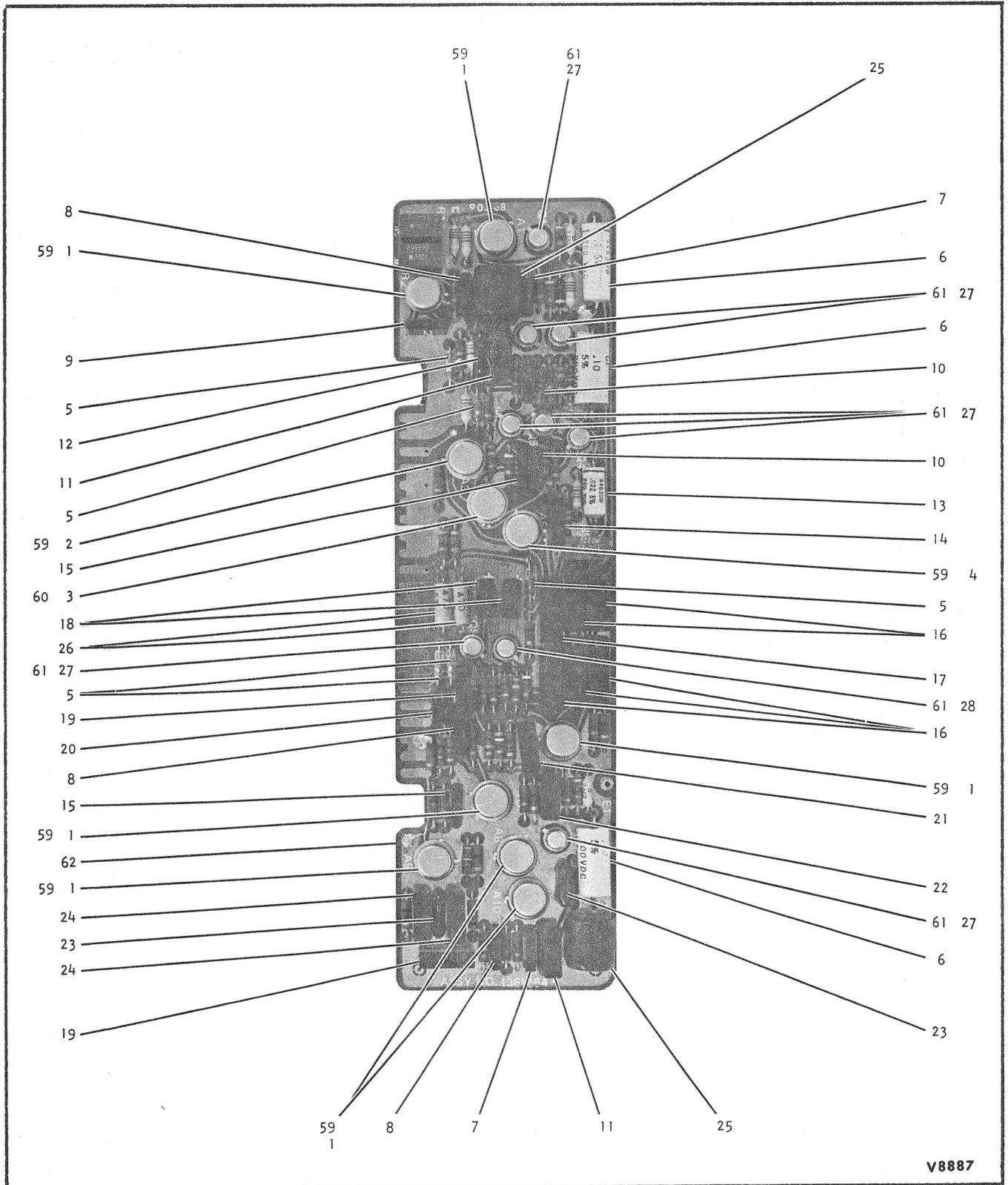
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Figure 11-12. Drum Servo (Board 15) (Sheet 4 of 4)

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
12	1361560-02			PRINTED WIRING ASSEMBLY, Head Drum Servo (See . . . Figure 2-7 For Next Higher Assembly)	Ref	
-1	586-024	∴		. CIRCUIT, Integrated (A1-4,6)	5	
-2	586-051	∴		. CIRCUIT, Integrated (A5)	1	
-3	013-689			. DIODE (CR1-6)	6	
-4	030-871			. CAPACITOR, Ceramic, 2μF, 50V, 10% (C1,32)	2	
-5	035-841			. CAPACITOR, Mylar, 0.0047μF, 50V, 10% (C2,7,9,22)	4	
-6	035-582			. CAPACITOR, Mylar, 0.056μF, 50V, 10% (C3)	1	
-7	056-162			. CAPACITOR, Mica, 300PF, 500V, 5% (C4,6,8)	3	
-8	035-858			. CAPACITOR, Mylar, 0.047μF, 50V, 10% (C5)	1	
-9	035-814			. CAPACITOR, Mylar, 0.033μF, 50V, 5% (C10,28)	2	
-10	034-208			. CAPACITOR, Mica, 30PF, 500V, 5% (C11,14,31)	3	
-11	055-582			. CAPACITOR, Poly, 0.1μF, 200V, 5% (C12)	1	
-12	035-893			. CAPACITOR, Mylar, 0.1μF, 50V, 5% (C13)	1	
-13	037-436			. CAPACITOR, Tantalum, 47μF, 25V, 10% (C15,23-26, . . . 29,30)	7	
-14	035-840			. CAPACITOR, Mylar, 0.01μF, 50V, 10% (C16,34)	2	
-15	037-439			. CAPACITOR, Tantalum, 22μF, 15V, 10% (C17)	1	
-16	034-254			. CAPACITOR, Mica, 1300PF, 500V, 1% (C18)	1	
-17	034-235			. CAPACITOR, Mica, 7500PF, 100V, 1% (C19,20)	2	
-18	034-363			. CAPACITOR, Mica, 2000PF, 100V, 1% (C21)	1	
-19	037-462			. CAPACITOR, Tantalum, 2.2μF, 25V, 10% (C27,35)	2	
-20	035-883			. CAPACITOR, Mylar, 0.068μF, 50V, 5% (C33)	1	
-21	014-600	∴		. TRANSISTOR (Q1,9,10)	3	
-22	014-505	∴		. TRANSISTOR (Q2,3,12,13)	4	
-23	014-506	∴		. TRANSISTOR (Q4-8,14-16,18)	9	
-24	014-248	∴		. TRANSISTOR (Q11)	1	
-25	014-852	∴		. TRANSISTOR, Dual, S1 (Q17)	1	
-26	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, . . . 5% (R1,23,63,65,66)	5	
-27	041-612			. RESISTOR, Carbon Composition, 30000 Ohm, 1/4W, . . . 5% (R2,3)	2	
-28	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, . . . 5% (R4,19,51)	3	
-29	057-961			. RESISTOR, Metal Film, 1400 Ohm, 1/10W, 1% (R5)	FS	
	062-014			. RESISTOR, Metal Film, 1270 Ohm, 1/10W, 1% (R5)	FS	
	062-015			. RESISTOR, Metal Film, 1300 Ohm, 1/10W, 1% (R5)	FS	
	062-016			. RESISTOR, Metal Film, 1330 Ohm, 1/10W, 1% (R5)	FS	
	062-017			. RESISTOR, Metal Film, 1370 Ohm, 1/10W, 1% (R5)	FS	
	062-018			. RESISTOR, Metal Film, 1430 Ohm, 1/10W, 1% (R5)	FS	
	062-019			. RESISTOR, Metal Film, 1470 Ohm, 1/10W, 1% (R5)	FS	
	062-020			. RESISTOR, Metal Film, 1500 Ohm, 1/10W, 1% (R5)	FS	
	062-021			. RESISTOR, Metal Film, 1540 Ohm, 1/10W, 1% (R5)	FS	
-30	041-505			. RESISTOR, Carbon Composition, 620 Ohm, 1/4W, ... 5% (R6,44)	2	
-31	057-962			. RESISTOR, Metal Film, 1580 Ohm, 1/10W, 1% (R7)	1	
-32	058-319			. RESISTOR, Variable, 200 Ohm, 1W, 5% (R8,9)	2	
-33	058-372			. RESISTOR, Variable, 50000 Ohm, 1W, 5% (R10)	1	
-34	041-411			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, ... 5% (R11,12,15,21,56)	5	
-35	041-409			. RESISTOR, Carbon Composition, 15000 Ohm, 1/4W, ... 5% (R13)	1	
-36	041-576			. RESISTOR, Carbon Composition, 390000 Ohm, 1/4W, ... 5% (R14)	1	
-37	057-143			. RESISTOR, Metal Film, 91000 Ohm, 1/4W, 2% (R16)	1	
-38	057-963			. RESISTOR, Metal Film, 2550 Ohm, 1/10W, 1% (R17)	1	
-39	057-960			. RESISTOR, Metal Film, 604 Ohm, 1/10W, 1% (R18)	FS	
	062-006			. RESISTOR, Metal Film, 549 Ohm, 1/10W, 1% (R18)	FS	
	062-007			. RESISTOR, Metal Film, 562 Ohm, 1/10W, 1% (R18)	FS	
	062-008			. RESISTOR, Metal Film, 576 Ohm, 1/10W, 1% (R18)	FS	
	062-009			. RESISTOR, Metal Film, 590 Ohm, 1/10W, 1% (R18)	FS	
	062-010			. RESISTOR, Metal Film, 619 Ohm, 1/10W, 1% (R18)	FS	
	062-011			. RESISTOR, Metal Film, 634 Ohm, 1/10W, 1% (R18)	FS	
	062-012			. RESISTOR, Metal Film, 649 Ohm, 1/10W, 1% (R18)	FS	
	062-013			. RESISTOR, Metal Film, 665 Ohm, 1/10W, 1% (R18)	FS	

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
12-40	041-419			. RESISTOR, Carbon Composition, 100 Ohm, 1/4W, ... 5% (R20, 24, 70)	3	
-41	041-432			. RESISTOR, Carbon Composition, 220000 Ohm, 1/4W, ... 5% (R22)	1	
-42	041-584			. RESISTOR, Carbon Composition, 4300 Ohm, 1/4W, ... 5% (R25)	1	
-43	041-559			. RESISTOR, Carbon Composition, 120 Ohm, 1/4W, ... 5% (R26)	1	
-44	057-971			. RESISTOR, Metal Film, 14300 Ohm, 1/10W, 1% (R27)	1	
-45	041-495			. RESISTOR, Carbon Composition, 8200 Ohm, 1/4W, ... 5% (R28)	1	
-46	057-961			. RESISTOR, Metal Film, 1400 Ohm, 1/10W, 1% (R29)	1	
-47	041-429			. RESISTOR, Carbon Composition, 680 Ohm, 1/4W, 5% (R30)	1	
-48	057-967			. RESISTOR, Metal Film, 4990 Ohm, 1/10W, 1% (R31)	1	
-49	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, ... 5% (R32, 37, 57, 58)	4	
-50	041-413			. RESISTOR, Carbon Composition, 6800 Ohm, 1/4W, ... 5% (R33, 72)	2	
-51	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, ... 5% (R34, 43, 45, 59)	4	
-52	057-122			. RESISTOR, Metal Film, 12000 Ohm, 1/4W, 2% (R35)	1	
-53	041-414			. RESISTOR, Carbon Composition, 2200 Ohm, 1/4W, 5% (R36, 71)	2	
-54	041-561			. RESISTOR, Carbon Composition, 33 Ohm, 1/4W, 5% (R38, 60, 61, 74-76)	6	
-55	041-412			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, ... 5% (R39)	1	
-56	057-113			. RESISTOR, Metal Film, 5100 Ohm, 1/4W, 2% (R40)	1	
-57	057-089			. RESISTOR, Metal Film, 510 Ohm, 1/4W, 2% (R41)	1	
-58	057-081			. RESISTOR, Metal Film, 240 Ohm, 1/4W, 2% (R42)	1	
-59	057-127			. RESISTOR, Metal Film, 20000 Ohm, 1/4W, 2% (R46)	1	
-60	057-120			. RESISTOR, Metal Film, 10000 Ohm, 1/4W, 2% (R47)	1	
-61	057-088			. RESISTOR, Metal Film, 470 Ohm, 1/4W, 2% (R48)	1	
-62	057-096			. RESISTOR, Metal Film, 1000 Ohm, 1/4W, 2% (R49)	1	
-63	041-427			. RESISTOR, Carbon Composition, 330 Ohm, 1/4W, ... 5% (R50)	1	
-64	041-393			. RESISTOR, Carbon Composition, 1 Megohm, 1/4W, ... 5% (R52)	1	
-65	041-554			. RESISTOR, Carbon Composition, 51 Ohm, 1/4W, ... 5% (F53)	1	
-66	041-530			. RESISTOR, Carbon Composition, 15 Ohm, 1/4W, ... 5% (R54, 55)	2	
-67	041-520			. RESISTOR, Carbon Composition, 7500 Ohm, 1/4W, ... 5% (R62)	1	
-68	041-508			. RESISTOR, Carbon Composition, 20000 Ohm, 1/4W, ... 5% (R64, 69)	2	
-69	041-538			. RESISTOR, Carbon Composition, 6200 Ohm, 1/4W, ... 5% (R67, 68)	2	
-70	041-778			. RESISTOR, Carbon Composition, 2.2 Megohm, 1/4W, ... 5% (R73)	1	
-71	013-202	∴		. DIODE (1N825) (VR1, 2)	2	
-72	013-983	∴		. DIODE (VR3)	1	
-73	580-160	∴		. PAD, Integrated Circuit	5	
-74	586-149	∴		. PAD, Integrated Circuit	1	
-75	280-100	∴		. PAD, Transistor Mounting	17	
-76	014-783	∴		. PAD, Transistor Mounting, Dual	1	
-77	1361561-03			. PRINTED WIRING BOARD	1	



V8887

Figure 11-13. Control Track (Board 14) (Sheet 1 of 2)

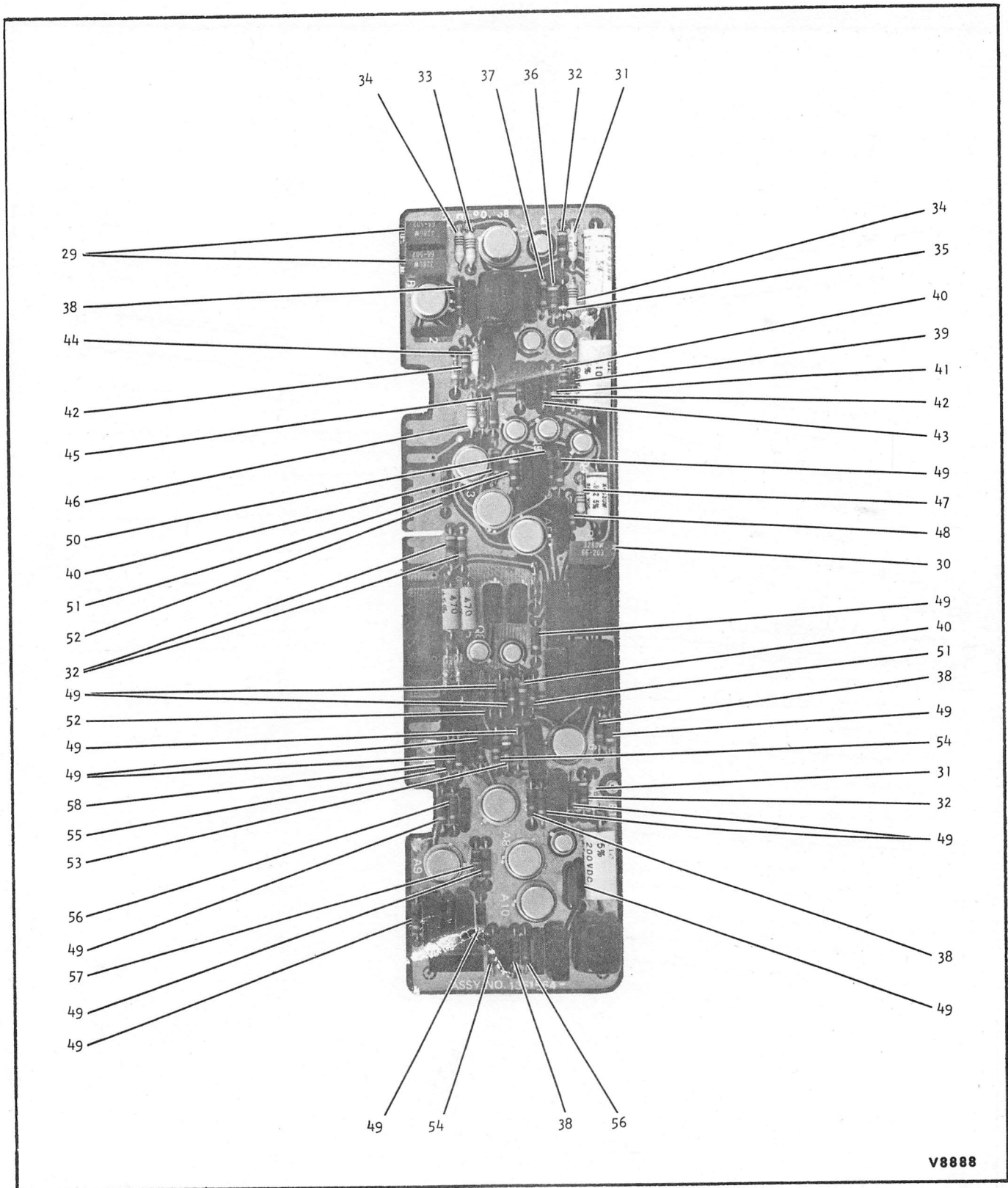


Figure 11-13. Control Track (Board 14) (Sheet 2 of 2)

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
13	1361564-01			PRINTED WIRING ASSEMBLY, Control Track (See Figure 2-8 For Next Higher Assembly)	Ref	
-1	586-024	∞		. CIRCUIT, Integrated (A1,2,6-10)	7	
-2	586-019	∞		. CIRCUIT, Integrated (A3)	1	
-3	586-051	∞		. CIRCUIT, Integrated (A4)	1	
-4	586-021	∞		. CIRCUIT, Integrated (A5)	1	
-5	013-689			. DIODE (CR1-5)	5	
-6	055-582			. CAPACITOR, PYC, 0.1μF, 200V, 5% (C1,5,27)	3	
-7	055-167			. CAPACITOR, Mylar, 0.0033μF, 50V, 5% (C2,30)	2	
-8	035-841			. CAPACITOR, Mylar, 0.0047μF, 50V, 10% (C3,24,31)	3	
-9	035-840			. CAPACITOR, Mylar, 0.01μF, 50V, 10% (C4)	1	
-10	055-144			. CAPACITOR, Mylar, 0.012μF, 50V, 5% (C6,11)	2	
-11	055-131			. CAPACITOR, Mylar, 0.039μF, 50V, 5% (C7,29)	2	
-12	056-163			. CAPACITOR, Mica, 470PF, 500V, 5% (C8)	1	
-13	055-581			. CAPACITOR, PYC, 0.022μF, 200V, 5% (C9)	1	
-14	035-816			. CAPACITOR, Mylar, 0.018μF, 50V, 5% (C10)	1	
-15	055-166			. CAPACITOR, Mylar, 0.001μF, 50V, 5% (C12,26)	2	
-16	037-436			. CAPACITOR, Tantalum, 47μF, 25V, 10% (C13,14,18-20)	5	
-17	037-426			. CAPACITOR, Tantalum, 82μF, 15V, 10% (C15)	1	
-18	037-463			. CAPACITOR, Tantalum, 4.7μF, 35V, 10% (C16,17)	2	
-19	030-819			. CAPACITOR, Ceramic, 1μF, 50V, 10% (C21,35)	2	
-20	037-519			. CAPACITOR, Tantalum, 1μF, 35V, 20% (C22)	1	
-21	035-883			. CAPACITOR, Mylar, 0.068μF, 50V, 5% (C23)	1	
-22	035-853			. CAPACITOR, Mylar, 0.056μF, 50V, 5% (C25)	1	
-23	034-208			. CAPACITOR, Mica, 30PF, 500V, 5% (C28,33)	2	
-24	035-837			. CAPACITOR, Mylar, 0.1μF, 50V, 10% (C32,34)	2	
-25	540-063	∞		. INDUCTOR, 10H, 3% (L1,4)	2	
-26	540-007	∞		. INDUCTOR, 470μH, 5% (L2,3)	2	
-27	014-506	∞		. TRANSISTOR (Q1-6,8,9)	8	
-28	014-505	∞		. TRANSISTOR (Q7)	1	
-29	058-321			. RESISTOR, Variable, 5000 Ohm, 1W, 5% (R1,2)	2	
-30	058-323			. RESISTOR, Variable, 20000 Ohm, 1W, 5% (R3)	1	
-31	057-969			. RESISTOR, Metal Film, 84500 Ohm, 1/10W, 1% (R4,45)	2	
-32	041-425			. RESISTOR, Carbon Composition, 47 Ohm, 1/4W, 5% (R,29,30,46)	4	
-33	057-122			. RESISTOR, Metal Film, 12000 Ohm, 1/4W, 2% (R6)	1	
-34	057-096			. RESISTOR, Metal Film, 1000 Ohm, 1/4W, 2% (R7,8)	2	
-35	057-113			. RESISTOR, Metal Film, 5100 Ohm, 1/4W, 2% (R9)	1	
-36	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, ... 5% (R10)	1	
-37	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, ... 5% (R11)	1	
-38	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, ... 5% (R12,38,49,58)	4	
-39	057-138			. RESISTOR, Metal Film, 56000 Ohm, 1/4W, 2% (R13)	1	
-40	041-407			. RESISTOR, Carbon Composition, 3300 Ohm, 1/4W, ... 5% (R14,27,33)	3	
-41	041-440			. RESISTOR, Carbon Composition, 1200 Ohm, 1/4W, ... 5% (R15)	1	
-42	041-406			. RESISTOR, Carbon Composition, 22000 Ohm, 1/4W, ... 5% (R16,19)	2	
-43	041-561			. RESISTOR, Carbon Composition, 5100 Ohm, 1/4W, ... 5% (R17)	1	
-44	057-128			. RESISTOR, Metal Film, 22000 Ohm, 1/4W, 2% (R18)	1	
-45	041-495			. RESISTOR, Carbon Composition, 8200 Ohm, 1/4W, ... 5% (R20)	1	
-46	057-122			. RESISTOR, Metal Film, 12000 Ohm, 1/4W, 2% (R21)	1	
-47	057-131			. RESISTOR, Metal Film, 30000 Ohm, 1/4W, 2% (R22)	1	
-48	041-409			. RESISTOR, Carbon Composition, 15000 Ohm, 1/4W, ... 5% (R23)	1	
-49	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, 5% (24,31,34,35,37,39,42,43,47,48,51-53,55,56)	15	
-50	041-442			. RESISTOR, Carbon Composition, 2700 Ohm, 1/4W, ... 5% (R25)	1	

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
13-51	041-514			. RESISTOR, Carbon Composition, 9100 Ohm, 1/4W, ... 5% (R26, 32)	2	
-52	041-504			. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, ... 5% (R28, 36)	2	
-53	041-653			. RESISTOR, Carbon Composition, 39 Ohm, 1/4W, ... 5% (R40)	1	
-54	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, ... 5% (R41, 59)	2	
-55	041-419			. RESISTOR, Carbon Composition, 100 Ohm, 1/4W, ... 5% (R44)	1	
-56	041-414			. RESISTOR, Carbon Composition, 2200 Ohm, 1/4W, ... 5% (R50, 57)	2	
-57	041-761			. RESISTOR, Carbon Composition, 300000 Ohm, 1/4W, ... 5% (R54)	1	
-58	041-503			. RESISTOR, Carbon Composition, 270 Ohm, 1/4W, ... 5% (R60)	1	
-59	586-160	∴		. PAD, Mounting, Integrated Circuit	9	
-60	586-149	∴		. PAD, Mounting, Integrated Circuit	1	
-61	280-100	∴		. PAD, Transistor Mounting	9	
-62	1361565-02			. PRINTED WIRING BOARD	1	

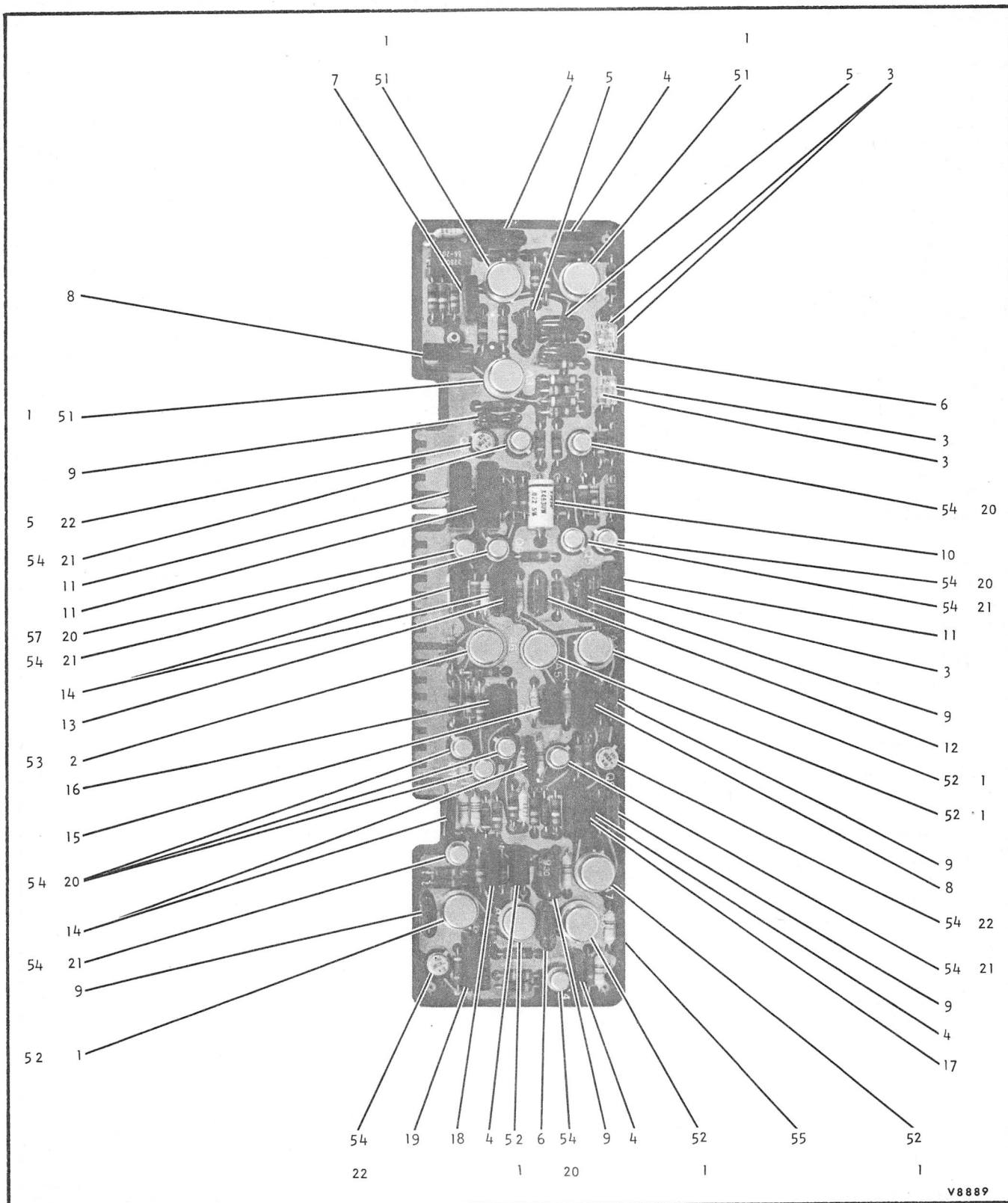
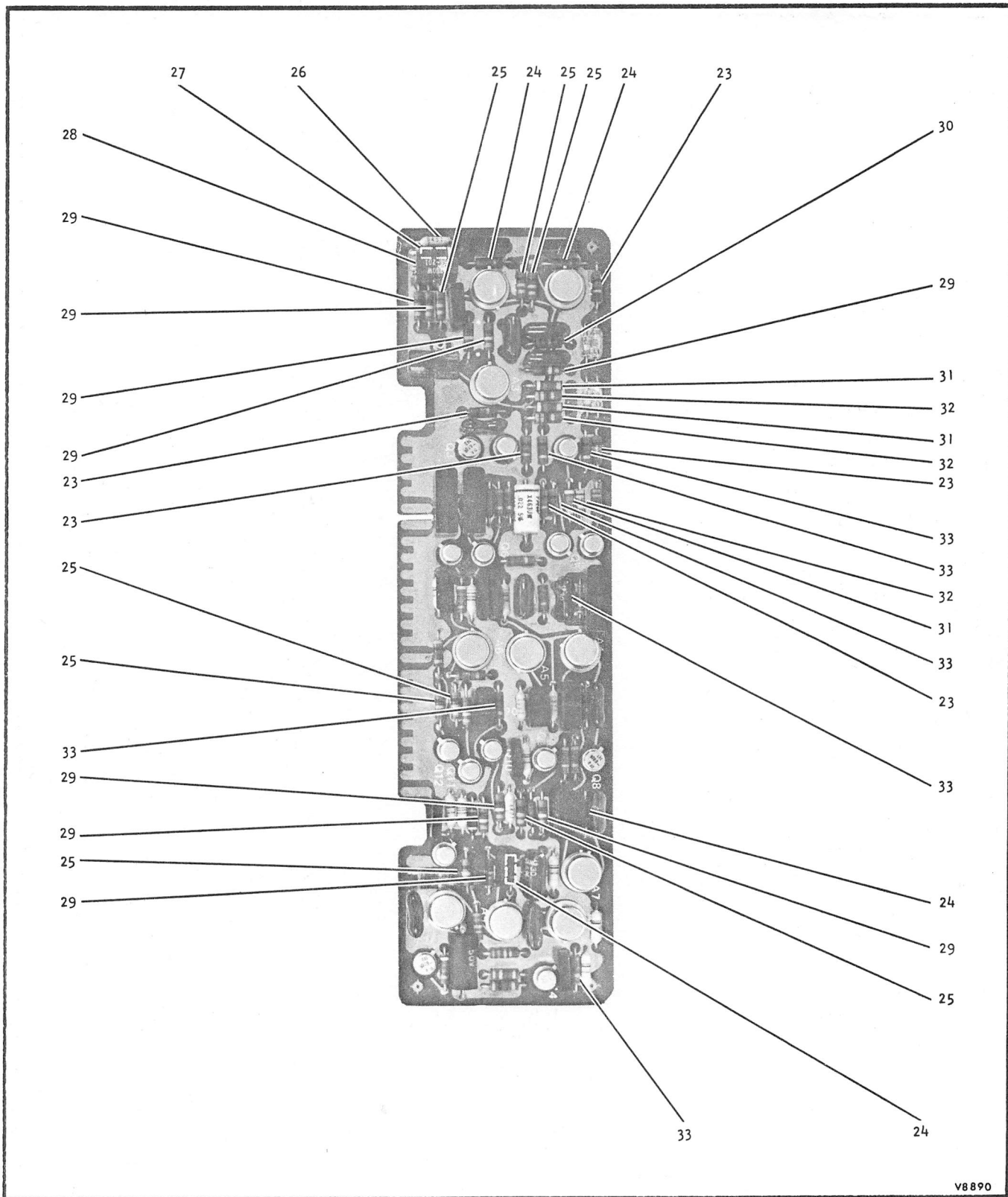
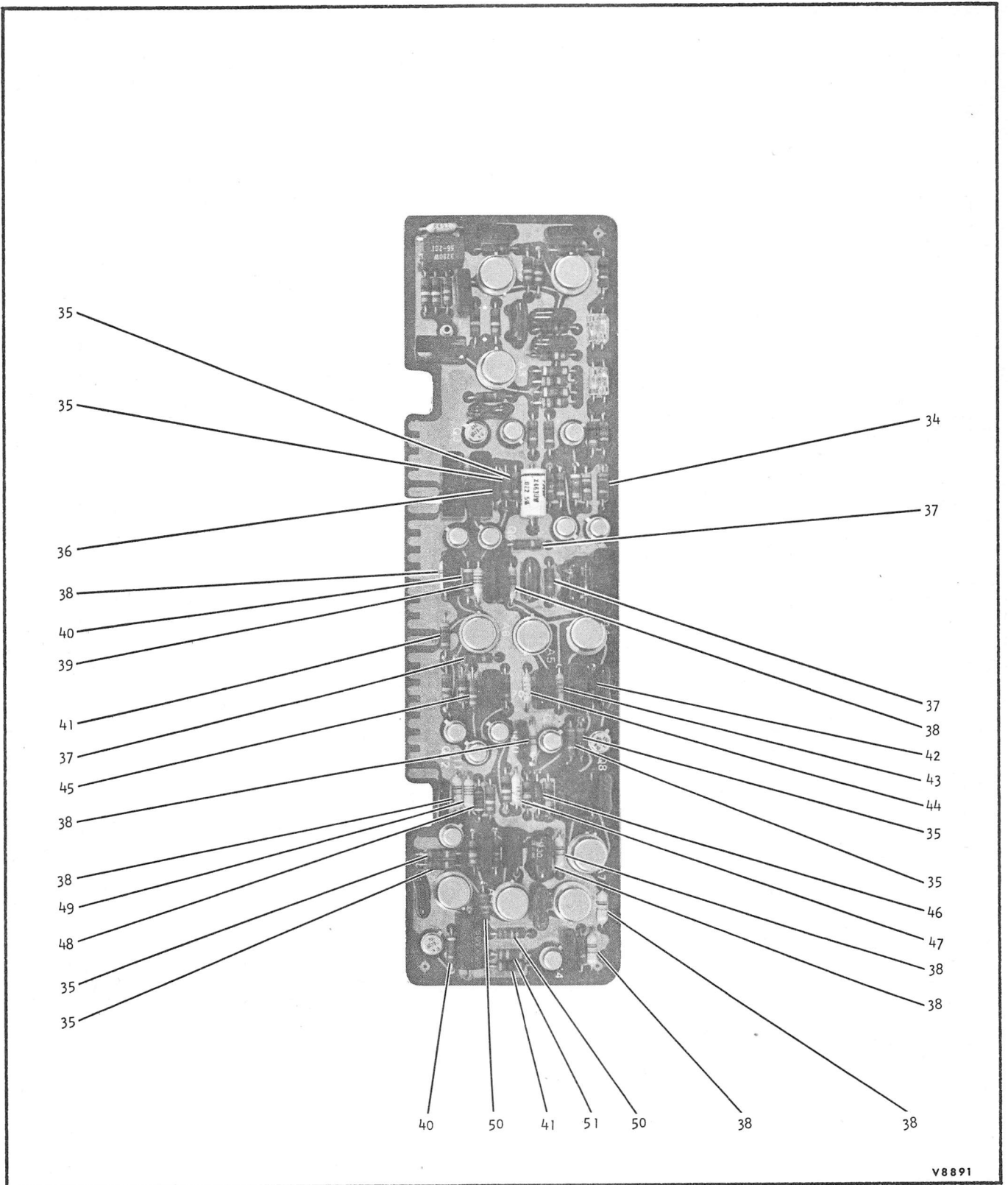


Figure 11-14. Capstan Servo (Board 13) (Sheet 1 of 3)



V8890

Figure 11-14. Capstan Servo (Board 13) (Sheet 2 of 3)



V8891

Figure 11-14. Capstan Servo (Board 13) (Sheet 3 of 3)

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
14	1361562-01			CAPSTAN SERVO (See Figure 2-9 For Next Higher Assembly) . . .	Ref	
-1	586-024	∴		. CIRCUIT, Integrated (A1-5, 7-10)	9	
-2	586-051	∴		. CIRCUIT, Integrated (A6)	1	
-3	013-589			. DIODE (CR1-5)	5	
-4	035-841			. CAPACITOR, Mylar, 0.0047μF, 50V, 10% (C1, 2, 25, 29, 33) . .	5	
-5	034-286			. CAPACITOR, Mica, 200PF, 500V, 5% (C3, 5)	2	
-6	056-161			. CAPACITOR, Mica, 100PF, 500V, 5% (C4, 31)	2	
-7	055-144			. CAPACITOR, Mylar, 0.012μF, 50V, 5% (C7)	1	
-8	035-893			. CAPACITOR, Mylar, 0.1μF, 50V, 5% (C8, 20)	2	
-9	034-208			. CAPACITOR, Mica, 30PF, 500V, 5% (C9, 14, 19, 24, 28, 32) .	6	
-10	055-581			. CAPACITOR, Poly, 0.022μF, 200V, 5% (C10)	1	
-11	037-436			. CAPACITOR, Tantalum, 47μF, 25V, 10% (C11-13)	3	
-12	034-347			. CAPACITOR, Mica, 180PF, 500V, 5% (C15)	1	
-13	035-729			. CAPACITOR, Mylar, 0.0015μF, 50V, 5% (C16)	1	
-14	055-135			. CAPACITOR, Mylar, 0.0027μF, 50V, 5% (C17, 18, 23, 27) . .	4	
-15	037-476			. CAPACITOR, Tantalum, 10μF, 25V, 10% (C21)	1	
-16	037-630			. CAPACITOR, Tantalum, 27μF, 15V, 10% (C22)	1	
-17	035-883			. CAPACITOR, Mylar, 0.068μF, 50V, 5% (C26)	1	
-18	055-167			. CAPACITOR, Mylar, 0.0033μF, 50V, 5% (C30)	1	
-19	030-879			. CAPACITOR, Ceramic, 1μF, 50V, 10% (C34)	1	
-20	014-506	∴		. TRANSISTOR, (Q1, 4, 7, 10, 11, 12, 14)	7	
-21	014-505	∴		. TRANSISTOR (Q2, 5, 6, 9, 13)	5	
-22	041-600	∴		. TRANSISTOR (Q3, 8, 15)	3	
-23	041-419			. RESISTOR, Carbon Composition, 100 Ohm, 1/4W, 5%	5	
				(R1, 20, 21, 24, 29)		
-24	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, 5%	4	
				(R2, 5, 51, 63)		
-25	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, 5%	7	
				(R3, 4, 9, 45, 46, 54, 65)		
-26	057-973			. RESISTOR, Metal Film, 8450 Ohm, 1/10W, 1% (R6)	1	
-27	062-022			. RESISTOR, Metal Film, 2800 Ohm, 1/10W, 1% (R7)	FS	
	062-023			. RESISTOR, Metal Film, 2870 Ohm, 1/10W, 1% (R7)	FS	
	062-024			. RESISTOR, Metal Film, 2940 Ohm, 1/10W, 1% (R7)	FS	
	062-025			. RESISTOR, Metal Film, 3010 Ohm, 1/10W, 1% (R7)	FS	
	057-964			. RESISTOR, Metal Film, 3090 Ohm, 1/10W, 1% (R7)	FS	
	062-026			. RESISTOR, Metal Film, 3160 Ohm, 1/10W, 1% (R7)	FS	
	062-027			. RESISTOR, Metal Film, 3240 Ohm, 1/10W, 1% (R7)	FS	
	062-028			. RESISTOR, Metal Film, 3320 Ohm, 1/10W, 1% (R7)	FS	
	062-029			. RESISTOR, Metal Film, 3400 Ohm, 1/10W, 1% (R7)	FS	
-28	058-319			. RESISTOR, Variable, 200 Ohm, 1W, 5% (R8)	1	
-29	041-394			. RESISTOR, Carbon Composition, 100000 Ohm, 1/4W, 5%	9	
				(R10, 11, 13-15, 52, 56, 57, 64)		
-30	041-469			. RESISTOR, Carbon Composition, 330000 Ohm, 1/4W, 5% (R12) .	1	
-31	041-412			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, 5%	3	
				(R16, 18, 27)		
-32	041-651			. RESISTOR, Carbon Composition, 33 Ohm, 1/4W, 5%	3	
				(R17, 19, 26)		
-33	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, 5%	6	
				(R22, 23, 28, 34, 43, 71)		
-34	041-413			. RESISTOR, Carbon Composition, 6800 Ohm, 1/4W, 5% (R25) . .	1	
-35	041-538			. RESISTOR, Carbon Composition, 6200 Ohm, 1/4W, 5%	6	
				(R30, 31, 48, 49, 66, 67)		
-36	057-972			. RESISTOR, Metal Film, 11500 Ohm, 1/10W, 1% (R32)	1	
-37	041-414			. RESISTOR, Carbon Composition, 2200 Ohm, 1/4W, 5%	3	
				(R33, 47, 76)		
-38	057-120			. RESISTOR, Metal Film, 10000 Ohm, 1/4W, 2% (R35, ...	8	
				38, 50, 60-62, 68, 70)		

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
14-39	057-113			. RESISTOR, Metal Film, 5100 Ohm, 14/W, 2% (R36)	1	
-40	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, 5% (R37, 75)	2	
-41	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, 5% (R39, 74)	2	
-42	041-740			. RESISTOR, Carbon Composition, 200 Ohm, 1/4W, 5% (R40) . .	1	
-43	057-974			. RESISTOR, Metal Film, 6810 Ohm, 1/10W, 1% (R41)	1	
-44	057-967			. RESISTOR, Metal Film, 4990 Ohm, 1/10W, 1% (R42)	1	
-45	041-483			. RESISTOR, Carbon Composition, 27000 Ohm, 1/4W, 5% (R44) .	1	
-46	057-968			. RESISTOR, Metal Film, 7680 Ohm, 1/10W, 1% (R53)	1	
-47	047-966			. RESISTOR, Metal Film, 4420 Ohm, 1/10W, 1% (R55)	1	
-48	057-118			. RESISTOR, Metal Film, 8200 Ohm, 1/4W, 2% (R58)	1	
-49	057-104			. RESISTOR, Metal Film, 2200 Ohm, 1/4W, 2% (R59)	1	
-50	041-415			. RESISTOR, Carbon Composition, 68000 Ohm, 1/4W, 5% (R69, 72)	2	
-51	041-407			. RESISTOR, Carbon Composition, 3300 Ohm, 1/4W, 5% (R73) . .	1	
-52	586-160	∴		. PAD, Mounting, Integrated Circuit	9	
-53	586-149	∴		. PAD, Mounting, Integrated Circuit	1	
-54	280-100	∴		. PAD, Transistor Mounting	15	
-55	1361563-02			. PRINTED WIRING BOARD.	1	



Figure 11-15. Control Logic (Board 12) (Sheet 1 of 2)

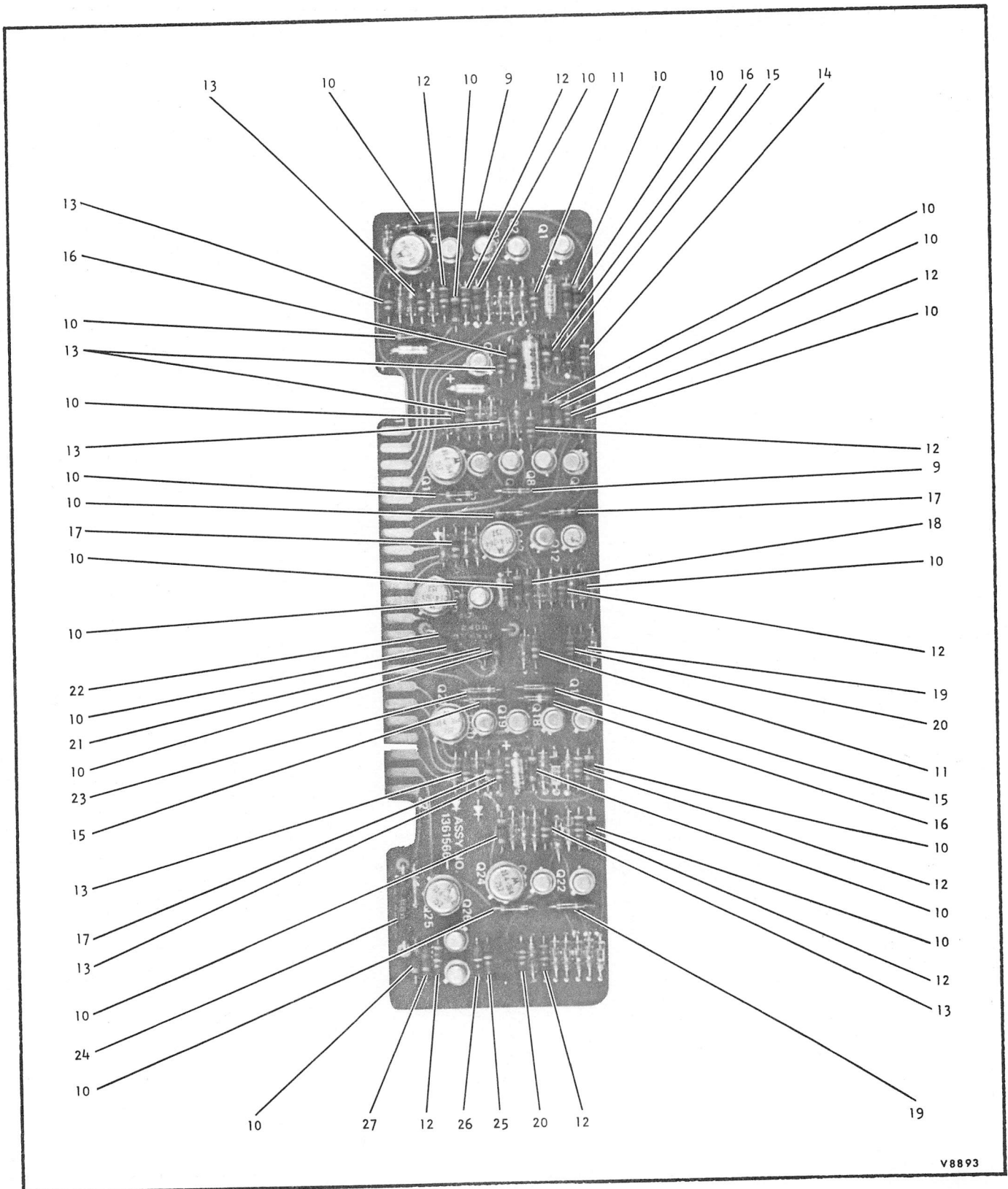


Figure 11-15. Control Logic (Board 12) (Sheet 2 of 2)

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
15	1361566-01			CONTROL LOGIC (See Figure 2-10 For Next Higher Assembly) . .	Ref	
-1	013-689			. DIODE (CR1-30, 32-37)	36	
-2	037-160			. CAPACITOR, Tantalum, 2.2 μ F, 20V (C1)	1	
-3	031-390			. CAPACITOR, Tantalum, 33 μ F, 10V (C2)	1	
-4	037-138			. CAPACITOR, Tantalum, 1 μ F, 20V, (C3-5, 7)	4	
-5	037-436			. CAPACITOR, Tantalum, 47 μ F, 25V (C6)	1	
-6	037-476			. CAPACITOR, Tantalum, 10 μ F, 25V (C8)	1	
-7	014-506	∴		. TRANSISTOR, (Q1-4, 6-10, 12, 13, 15, 17-20, 22, 23, 26, 27) .	20	
-8	014-364	∴		. TRANSISTOR (Q5, 11, 14, 16, 21, 24, 25)	7	
-9	041-561			. RESISTOR, Carbon Composition, 5100 Ohm, 1/4W, 5% (R1, 26) .	2	
-10	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, 5% (R2-4, 6, 8, 12, 18, 20, 21, 25, 27, 29, 31, 33, 34, 38, 41, 46, 48, 52, 55, 57, 65)	23	
-11	041-436			. RESISTOR, Carbon Composition, 18000 Ohm, 1/4W, 5% (R5, 37)	2	
-12	041-751			. RESISTOR, Carbon Composition, 36000 Ohm, 1/4W, 5% (R7, 9, 19, 22, 47, 53, 59, 63, 66)	9	
-13	041-483			. RESISTOR, Carbon Composition, 27000 Ohm, 1/4W, 5% (R10, 11, 17, 23, 24, 49, 51, 54)	8	
-14	041-411			. RESISTOR, Carbon Composition, 47000 Ohm, 1/4W, 5% (R13) .	1	
-15	041-495			. RESISTOR, Carbon Composition, 8200 Ohm, 1/4W, 5% (R14, 42, 45)	3	
-16	041-394			. RESISTOR, Carbon Composition, 100000 Ohm, 1/4W, 5% (R15, 16, 43)	3	
-17	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, 5% (R28, 30, 50)	3	
-18	041-437			. RESISTOR, Carbon Composition, 1600 Ohm, 1/4W, 5% (R32) . .	1	
-19	041-538			. RESISTOR, Carbon Composition, 6200 Ohm, 1/4W, 5% (R35, 56)	2	
-20	041-549			. RESISTOR, Carbon Composition, 13000 Ohm, 1/4W, 5% (R36, 60)	2	
-21	041-427			. RESISTOR, Carbon Composition, 330 Ohm, 1/4W, 5% (R39) . .	1	
-22	059-226			. RESISTOR, Wirewound, 240 Ohm, 3W, 3% (R40)	1	
-23	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, 5% (R44) . .	1	
-24	059-224			. RESISTOR, Wirewound, 68 Ohm, 3W, 3% (R58)	1	
-25	041-758			. RESISTOR, Carbon Composition, 2000000 Ohm, 1/4W, 5% (R61) .	1	
-26	041-574			. RESISTOR, Carbon Composition, 110000 Ohm, 1/4W, 5% (R62) .	1	
-27	041-434			. RESISTOR, Carbon Composition, 1800 Ohm, 1/4W, 5% (R64) . .	1	
-28	013-983	∴		. DIODE (VR1)	1	
-29	280-130	∴		. PAD, Transistor Mounting	20	
-30	280-998	∴		. PAD, Transistor Mounting	7	
-31	1361567-02			. PRINTED WIRING BOARD	1	

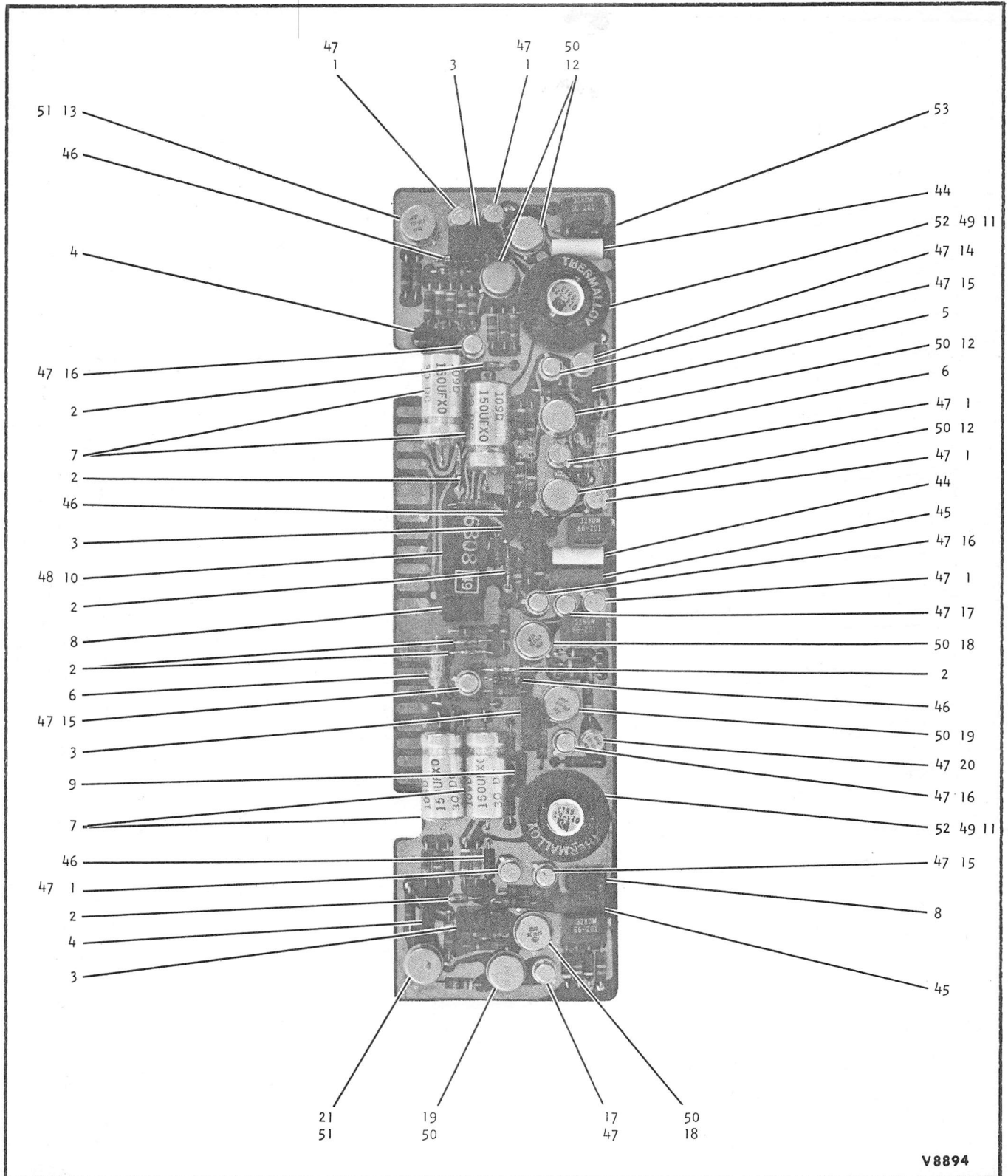


Figure 11-16. 12 Volt Regulator (Board 11) (Sheet 1 of 2)

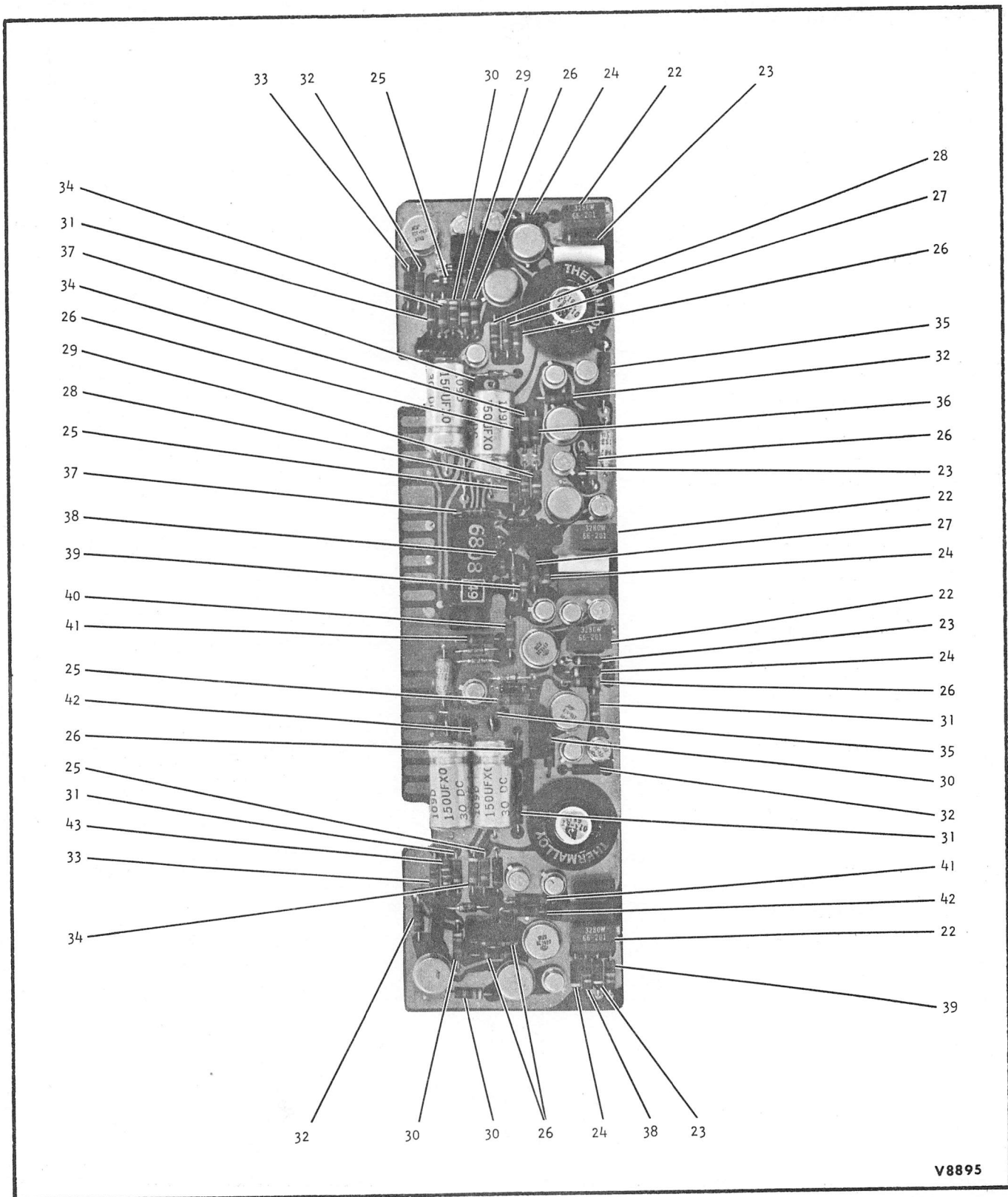


Figure 11-16. 12 Volt Regulator (Board 11) (Sheet 2 of 2)

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
16	1361588-01			12 VOLT REGULATOR AND POWER SUPPLY (See Figure 2-11 For Next Higher Assembly)	Ref	
-1	013-910	∴		. DIODE (CR1, 2, 5, 6, 8, 12)	6	
-2	013-599	∴		. DIODE *CR3, 4, 7, 9-11, 13)	7	
-3	035-837			. CAPACITOR, Mylar, 0.1μF, 50V, 10% (C1, 7, 9, 15)	4	
-4	035-839			. CAPACITOR, Mylar, 0.022μF, 50V, 10% (C2, 16)	2	
-5	035-842			. CAPACITOR, Mylar, 0.0033μF, 50V, 10% (C3)	1	
-6	037-058			. CAPACITOR, Tantalum, 1μF, 35V, 20% (C4, 10)	2	
-7	037-117			. CAPACITOR, Tantalum, 150μF, 30V, 20% (C5, 6, 12, 13)	4	
-8	037-476			. CAPACITOR, Tantalum, 10μF, 25V, 10% (C8, 14)	2	
-9	035-840			. CAPACITOR, Mylar, 0.01μF, 50V, 10% (C11)	1	
-10	020-563			. RELAY (K1)	1	
-11	041-629	∴		. TRANSISTOR (Q1, 17)	2	
-12	041-631			. TRANSISTOR (Q2, 3, 8, 9)	4	
-13	014-247	∴		. TRANSISTOR (Q4)	1	
-14	014-248	∴		. TRANSISTOR (Q5)	1	
-15	014-383	∴		. TRANSISTOR (Q6, 13, 18)	3	
-16	014-505	∴		. TRANSISTOR (Q7, 11, 16)	3	
-17	014-506	∴		. TRANSISTOR (Q10, 20)	2	
-18	014-628	∴		. TRANSISTOR (Q12, 19)	2	
-19	014-597			. TRANSISTOR (Q14, 21)	2	
-20	014-387	∴		. TRANSISTOR (Q15)	1	
-21	014-364	∴		. TRANSISTOR (Q22)	1	
-22	058-319			. RESISTOR, Variable, 200 Ohm, 1W, 5% (R1, 26, 33, 54)	4	
-23	057-098			. RESISTOR, Metal Film, 1200 Ohm, 1/4W, 2% (R2, 22, 34, 56)	4	
-24	057-096			. RESISTOR, Metal Film, 1000 Ohm, 1/4W, 2% (R3, ... 27, 35, 58)	4	
-25	041-506			. RESISTOR, Carbon Composition, 820 Ohm, 1/4W, 5% (R4, 24, 39, 48)	4	
-26	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, 5%. (R5, 8, 19, 21, 37, 43, 59, 60)	8	
-27	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, 5%. (R6, 28)	2	
-28	041-411			. RESISTOR, Carbon Composition, 47000 Ohm, 1/4W, 5% (R7, 25)	2	
-29	041-394			. RESISTOR, Carbon Composition, 100000 Ohm, 1/4W, 5%. (R9, 23)	2	
-30	041-584			. RESISTOR, Carbon Composition, 4300 Ohm, 1/4W, 5% (R10, 38, 61, 62)	4	
-31	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, 5% (R11, 41, 45, 51)	4	
-32	041-740			. RESISTOR, Carbon Composition, 200 Ohm, 1/4W, 5% (R12, 16, 42, 53)	4	
-33	041-418			. RESISTOR, Carbon Composition, 22 Ohm, 1/4W, 5%. (R13, 52)	2	
-34	041-412			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, 5% (R14, 18, 50)	3	
-35	043-380			. RESISTOR, Wirewound, 1 Ohm, 1W, 3% (R15, 40)	2	
-36	041-538			. RESISTOR, Carbon Composition, 6200 Ohm, 1/4W, 5% (R17)	1	
-37	041-750			. RESISTOR, Carbon Composition, 24000 Ohm, 1/4W, 5% (R20, 30)	2	
-38	041-508			. RESISTOR, Carbon Composition, 20000 Ohm, 1/4W, 5% (R29, 57)	2	
-39	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, 5% (R31, 55)	2	

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1809993

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
16-40	041-413			. RESISTOR, Carbon Composition, 6800 Ohm, 1/4W, 5% (R32) . .	1	
-41	041-440			. RESISTOR, Carbon Composition, 1200 Ohm, 1/4W, 5%	2	
				(R36, 46)		
-42	041-482			. RESISTOR, Carbon Composition, 12000 Ohm, 1/4W, 5%	2	
				(R44, 47)		
-43	041-549			. RESISTOR, Carbon Composition, 13000 Ohm, 1/4W, 5% (R49) .	1	
-44	148-028	∴		. TEST POINT, Tip Jack, Printed Circuit (White) (TP1, 2)	2	
-45	148-027	∴		. TEST POINT, Tip Jack, Printed Circuit (Red)(TP3, 4)	2	
-46	013-202	∴		. DIODE (1N825) (VR1-4)	4	
-47	280-130	∴		. PAD, Transistor Mounting	16	
-48	020-407	∴		. PAD, Relay Mounting	1	
-49	580-093	∴		. PAD, Transistor Mounting	2	
-50	014-914			. PAD, Transistor Mounting	8	
-51	280-998	∴		. PAD, Transistor Mounting	2	
-52	435-993			. HEAT SINK, Transistor.	2	
-53	1361589-03			. PRINTED WIRING BOARD.	1	

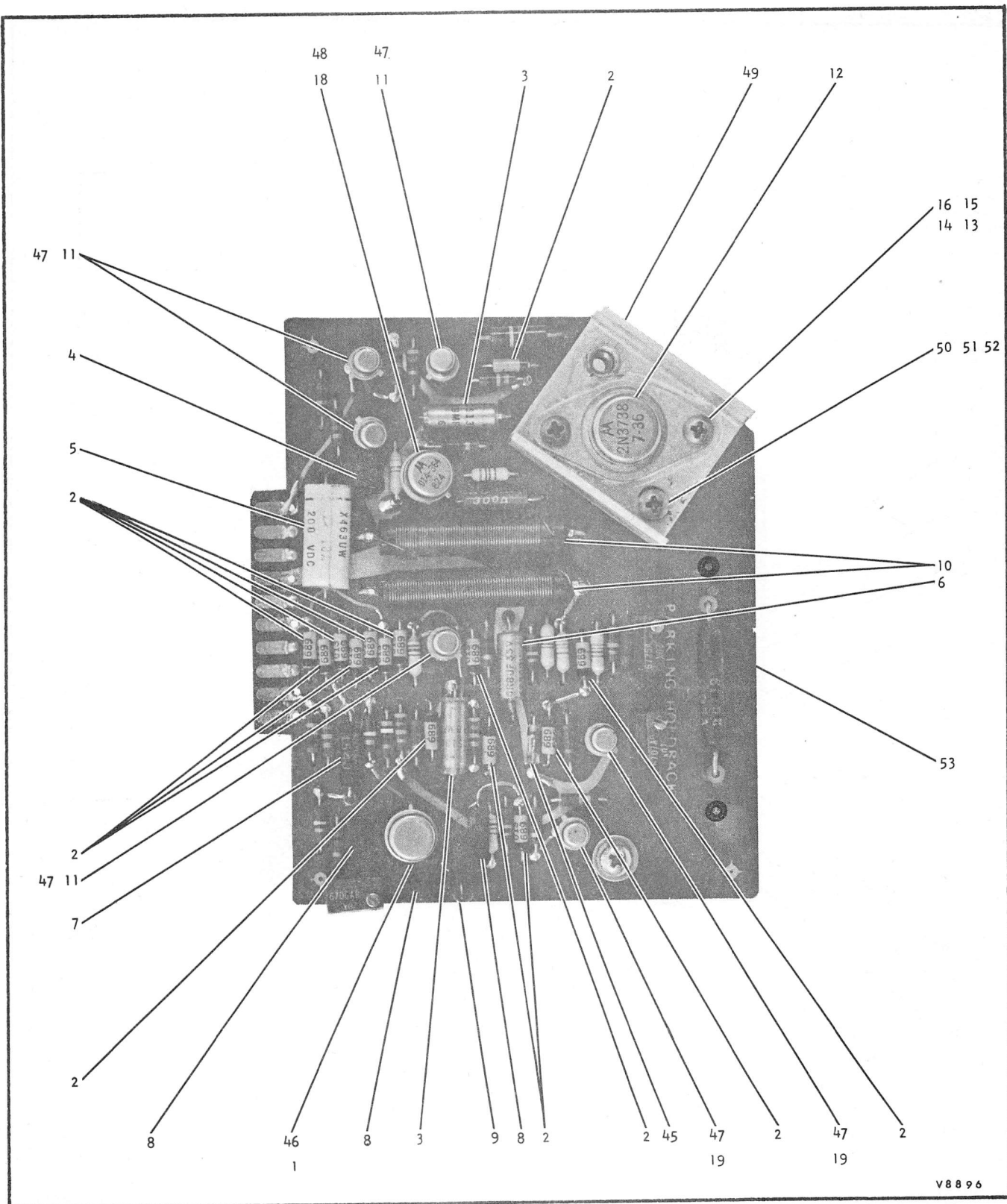


Figure 11-17. Takeup Motor Driver (Board 26) (Sheet 1 of 2)

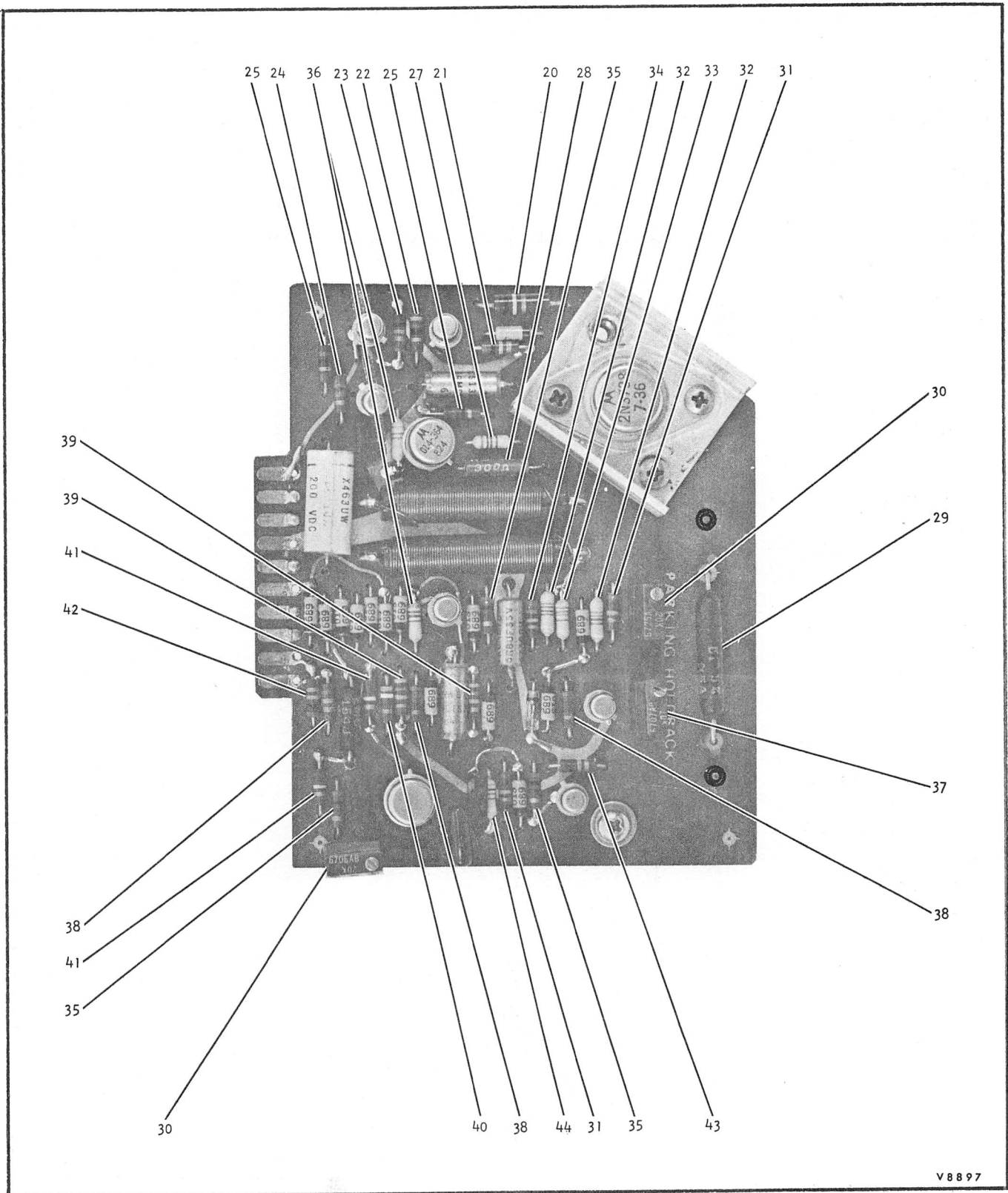


Figure 11-17. Takeup Motor Driver (Board 26) (Sheet 2 of 2)

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
17	1363799-01			TAKE-UP MOTOR DRIVER (See Figure 2-12 For Next Higher Assembly)	Ref	
-1	586-024	∴		. CIRCUIT, Integrated (A1)	1	
-2	013-689			. DIODE (CR1-14)	14	
-3	037-136			. CAPACITOR, Tantalum, 0.39μF, 10V, 10% (C1, 5)	2	
-4	037-462			. CAPACITOR, Tantalum, 2.2μF, 25V, 10% (C2)	1	
-5	055-608			. CAPACITOR, Phenolic, 0.22μF, 200V, 10% (C3)	1	
-6	037-153			. CAPACITOR, Tantalum, 6.8μF, 35V, 10% (C4)	1	
-7	030-883			. CAPACITOR, Ceramic, 0.15μF, 50V, 5% (C6)	1	
-8	035-840			. CAPACITOR, Mylar, 0.01μF, 50V, 10% (C7, 9, 10)	3	
-9	034-286			. CAPACITOR, Mica, 200PF, 500V, 5% (C8)	1	
-10	051-634			. INDUCTOR, 100μH, (L1, 2)	2	
-11	014-505	∴		. TRANSISTOR (Q1, 2, 6)	3	
-12	014-948	∴		. TRANSISTOR (2N3738) (Q3)	1	
-13	471-062			. SCREW, Pan Head, 4-40 x 3/8 Lg (AP)	2	
-14	501-002			. WASHER, Flat, #4 (AP)	2	
-15	580-143	∴		. WASHER, Insulating, Transistor (AP)	1	
-16	496-004			. NUT, Assembled Washer, 4-40 (AP)	2	
-17	014-383	∴		. TRANSISTOR (Q4)	1	
-18	014-364	∴		. TRANSISTOR (Q5)	1	
-19	014-506	∴		. TRANSISTOR (Q7, 8)	2	
-20	041-023			. RESISTOR, Carbon Composition, 100000 Ohms, 1/2W, 5% . . . (R1)	1	
-21	041-394			. RESISTOR, Carbon Composition, 100000 Ohms, 1/4W, 5% . . . (R2)	1	
-22	041-425			. RESISTOR, Carbon Composition, 47 Ohm, 1/4W, 5% (R3) . . .	1	
-23	041-508			. RESISTOR, Carbon Composition, 20000 Ohm, 1/4W, 5% (R4) . .	1	
-24	041-503			. RESISTOR, Carbon Composition, 270 Ohm, 1/4W, 5% (R5) . . .	1	
-25	041-652			. RESISTOR, Carbon Composition, 270 Ohm, 1/4W, 5% (R6, 7)	2	
-26	041-417			. RESISTOR, Carbon Composition, 390 Ohm, 1/4W, 5% (R8) . . .	1	
-27	041-504			. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, 5% (R9) . . .	1	
-28	047-427			. RESISTOR, Wirewound, 300 Ohm, 1W, 1% (R10)	1	
-29	043-741			. RESISTOR, Wirewound, 5 Ohm, 3W, 5% (R11)(Ref TP1 & TP2) .	1	
-30	058-330			. RESISTOR, Variable, Wirewound, 20000 Ohm, 1W, 5% (R12, 36)	2	
-31	041-482			. RESISTOR, Carbon Composition, 12000 Ohm, 1/4W, 5% (R13, 32)	2	
-32	041-538			. RESISTOR, Carbon Composition, 6200 Ohm, 1/4W, 5% (R14, 16)	2	
-33	041-519			. RESISTOR, Carbon Composition, 56000 Ohm, 1/4W, 5% (R15) .	1	
-34	041-757			. RESISTOR, Carbon Composition, 160000 Ohm, 1/4W, 5% (R17) .	1	
-35	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, 5% (R18, 31, 34)	3	
-36	041-561			. RESISTOR, Carbon Composition, 5100 Ohm, 1/4W, 5% (R19) . .	1	
-37	058-329			. RESISTOR, Variable, Wirewound, 10000 Ohm, 1W, 5% (R20) . .	1	
-38	041-520			. RESISTOR, Carbon Composition, 7500 Ohm, 1/4W, 5% (R21, 23, 28)	3	
-39	041-751			. RESISTOR, Carbon Composition, 36000 Ohm, 1/4W, 5% (R22, 24)	2	
-40	041-511			. RESISTOR, Carbon Composition, 3900 Ohm, 1/4W, 5% (R25) . .	1	
-41	041-432			. RESISTOR, Carbon Composition, 220000 Ohm, 1/4W, 5% (R26, 35)	2	
-42	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, 5% (R29) .	1	
-43	041-409			. RESISTOR, Carbon Composition, 15000 Ohm, 1/4W, 5% (R30) .	1	
-44	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, 5% (R33) . .	1	
-45	013-224	∴		. DIODE (VR1)	1	
-46	280-173	∴		. SPACER, Integrated Circuit	1	
-47	280-130	∴		. SPACER, Transistor	6	

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1809993

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
17-48	280-998	∞		. SPACER, Transistor	1	
-49	1363802-01			. BRACKET, Heat Sink	1	
-50	471-061			. SCREW, Pan Head, 4-40 x 5/16 Lg (AP)	1	
-51	501-002			. WASHER, Flat, #4 (AP)	1	
-52	496-004			. NUT, Assembled Washer, 4-40 (AP)	1	
-53	1363800-01			. PRINTED WIRING BOARD	1	

11-79

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1809993

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
18	1361738-01			POWER DISTRIBUTION (See Figure 2-13 For Next Higher Assembly)	Ref	
-1	013-599	∴		. DIODE (CR1-6)	6	
-2	037-241			. CAPACITOR, Tantalum, 100μF, 20V (C1-4)	4	
-3	020-563			. RELAY (K1-4)	4	
-4	059-223			. RESISTOR, Wirewound, 50 Ohm, 3W, 3% (R1, 2)	2	
-5	020-407	∴		. PAD, Relay Mounting	4	
-6	1361739-01			. PRINTED WIRING BOARD	1	

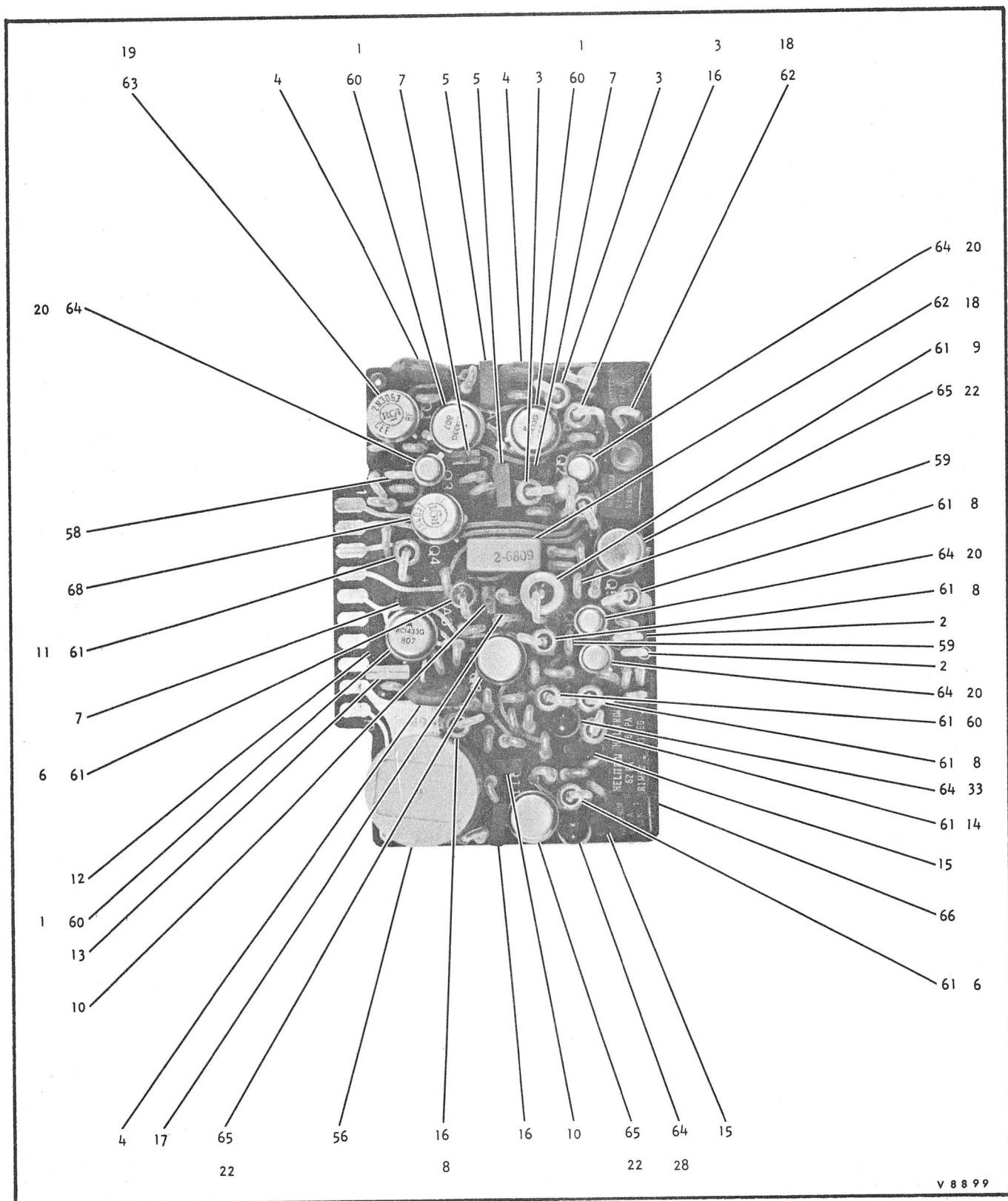


Figure 11-19. Audio AGC Amplifier (Board 24) (Sheet 1 of 2)

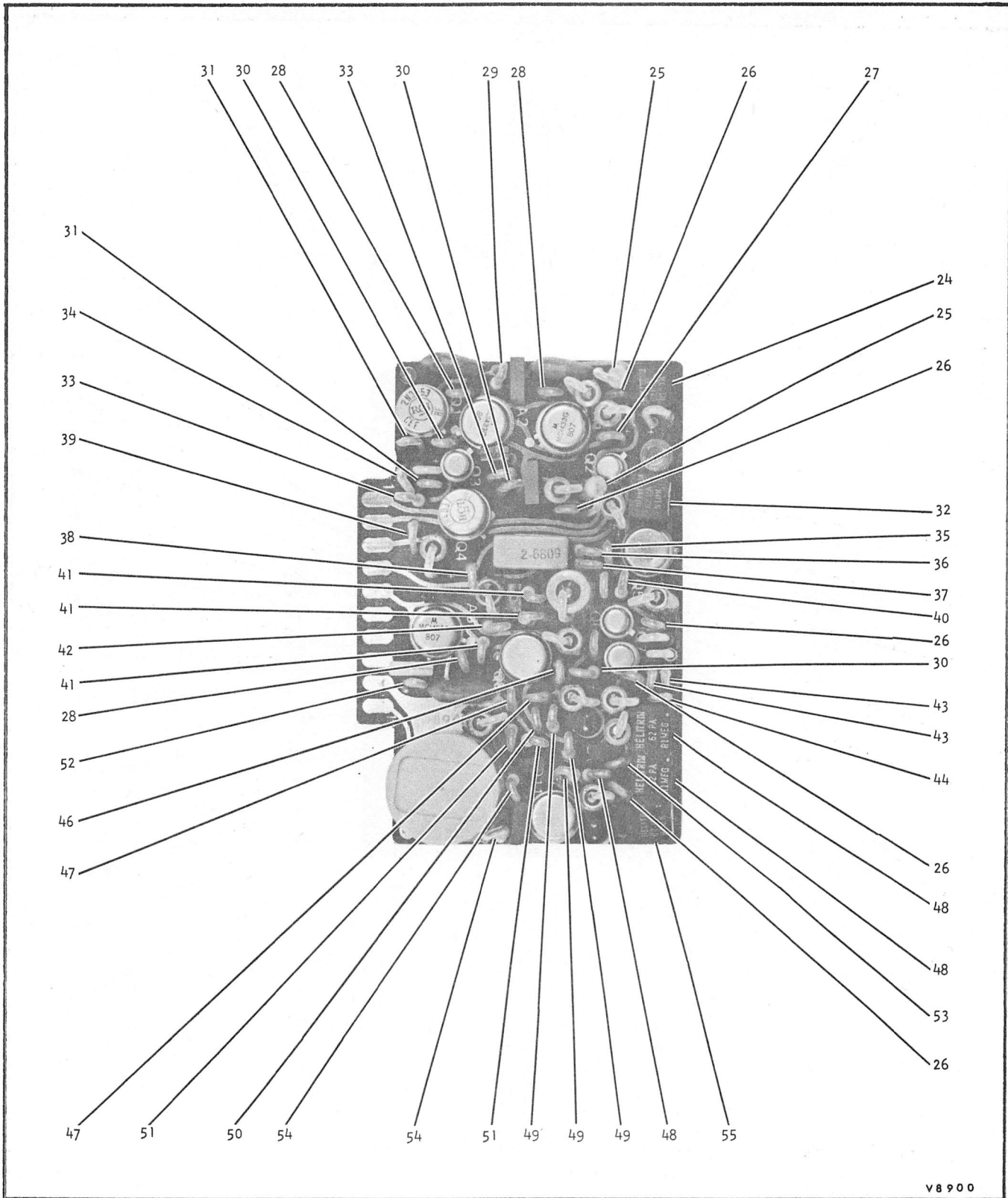


Figure 11-19. Audio AGC Amplifier (Board 24) (Sheet 2 of 2)

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
19	1361592-02			AUDIO AGC AMPLIFIER (See Figure 2-14 For Next Higher Assembly)	Ref	
-1	586-161	..		. CIRCUIT, Integrated (A1-3)	3	
-2	013-689			. DIODE, (CR1, 2)	2	
-3	037-028			. CAPACITOR, Tantalum, 22 μ F, 15V, 20% (C1, 2, 8)	3	
-4	030-144			. CAPACITOR, Ceramic, 0.05 μ F, 100V, 20% (C3, 5, 21)	3	
-5	030-495			. CAPACITOR, Ceramic, 0.01 μ F, 200V, 10% (C4, 9)	2	
-6	037-035			. CAPACITOR, Tantalum, 40 μ F, 10V, 20% (C6, 15, 20, 28)	4	
-7	030-829			. CAPACITOR, Ceramic, 10PF, 200V, 10% (C7, 10, 17)	3	
-8	037-109			. CAPACITOR, Tantalum, 10 μ F, 20V, 10% (C11, 13, 19, 26)	4	
-9	037-256			. CAPACITOR, Tantalum, 47 μ F, 20V, 10% (C12)	1	
-10	030-880			. CAPACITOR, Ceramic, 100PF, 200V, 10% (C14, 25)	2	
-11	037-107			. CAPACITOR, Tantalum, 2.2 μ F, 35V, 20% (C16)	1	
-12	030-884			. CAPACITOR, Ceramic, 820PF, 200V, 10% (C18)	1	
-13	030-885			. CAPACITOR, Ceramic, 2200PF, 200V, 5% (C22)	1	
-14	037-985			. CAPACITOR, Tantalum, 15 μ F, 20V, 10% (C23)	1	
-15	030-881			. CAPACITOR, Ceramic, 220PF, 200V, 10% (C24, 27)	2	
-16	030-295			. CAPACITOR, Ceramic, 4700PF, 200V, 10% (C29)	1	
-17	030-789			. CAPACITOR, Ceramic, 47PF, 200V, 10% (C30)	1	
-18	020-562			. RELAY (K1)	1	
-19	014-590	..		. TRANSISTOR (2N3053) (Q1)	1	
-20	014-506	..		. TRANSISTOR (Q2, 3, 6, 7)	4	
-21	014-723	..		. TRANSISTOR (2N4037) (Q4)	1	
-22	014-672			. TRANSISTOR (Q5, 8, 11)	3	
-23	041-950	..		. TRANSISTOR (2N4342) (Q9, 10)	2	
-24	058-124			. RESISTOR, Variable, 100000 Ohm, 1/2W, 30% (R1)	1	
-25	057-453			. RESISTOR, Metal Film, 4990 Ohm, 1/4W, 1% (R2, 11)	2	
-26	041-508			. RESISTOR, Carbon Composition, 20000 Ohm, 1/4W, 5% (R3, 12, 27, 31, 46)	5	
-27	041-407			. RESISTOR, Carbon Composition, 3300 Ohm, 1/4W, 5% (R4)	1	
-28	041-496			. RESISTOR, Carbon Composition, 10 Ohm, 1/4W, 5% (R5, 7, 36)	3	
-29	057-113			. RESISTOR, Metal Film, 5100 Ohm, 1/4W, 2% (R6)	1	
-30	041-414			. RESISTOR, Carbon Composition, 2200 Ohm, 1/4W, 5% (R8, 14, 34)	3	
-31	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, 5% (R9, 15)	2	
-32	058-333			. RESISTOR, Variable, 10000 Ohm, 1/2W, 30% (R10)	1	
-33	057-108			. RESISTOR, Metal Film, 3300 Ohm, 1/4W, 2% (R13, 16)	2	
-34	057-083			. RESISTOR, Metal Film, 300 Ohm, 1/4W, 2% (R17)	1	
-35	041-742			. RESISTOR, Carbon Composition, 360 Ohm, 1/4W, 5% (R18)	1	
-36	057-110			. RESISTOR, Metal Film, 3900 Ohm, 1/4W, 2% (R19)	1	
-37	057-109			. RESISTOR, Metal Film, 3600 Ohm, 1/4W, 2% (R20)	1	
-38	041-768			. RESISTOR, Carbon Composition, 750000 Ohm, 1/4W, 5% (R21)	1	
-39	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, 5% (R22)	1	
-40	057-102			. RESISTOR, Metal Film, 1800 Ohm, 1/4W, 2% (R23)	1	
-41	057-124			. RESISTOR, Metal Film, 15000 Ohm, 1/4W, 2% (R24, 25, 53)	3	
-42	057-131			. RESISTOR, Metal Film, 30000 Ohm, 1/4W, 2% (R26)	1	
-43	041-761			. RESISTOR, Carbon Composition, 300000 Ohm, 1/4W, 5% (R28, 30)	2	
-44	041-563			. RESISTOR, Carbon Composition, 240000 Ohm, 1/4W, 5% (R29)	1	
-45	057-103			. RESISTOR, Metal Film, 200 Ohm, 1/4W, 2% (R32)	1	
-46	041-511			. RESISTOR, Carbon Composition, 3900 Ohm, 1/4W, 5% (R33)	1	
-47	057-114			. RESISTOR, Metal Film, 5600 Ohm, 1/4W, 2% (R35, 37)	2	

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1809993

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
19-48	058-273			. RESISTOR, Variable, 1 Megohm, 1/2W, 30% (R38, 44)	2	
-49	057-134			. RESISTOR, Metal Film, 39000 Ohm, 1/4W, 2% (R39, 47, ... 48, 49)	4	
-50	041-436			. RESISTOR, Carbon Composition, 18000 Ohm, 1/4W, 5% (R40)	1	
-51	057-127			. RESISTOR, Metal Film, 20000 Ohm, 1/4W, 2% (R41, 42)	2	
-52	041-778			. RESISTOR, Carbon Composition, 2.2 Megohm, 1/4W, 5% (R43)	1	
-53	041-770			. RESISTOR, Carbon Composition, 910000 Ohm, 1/4W, 5% (R45) .	1	
-54	057-120			. RESISTOR, Metal Film, 10000 Ohm, 1/4W, 2% (R50, 52)	2	
-55	058-335			. RESISTOR, Variable, 50000 Ohm, 1/2W, 30% (R51)	1	
-56	4580197-01			. TRANSFORMER, Mike Input (Ampex Specification Drawing) . . (T1)	1	
-57	013-625	∴		. DIODE (1N823A) (VR1)	1	
-58	013-166	∴		. DIODE (VR2)	1	
-59	013-983	∴		. DIODE (VR3, 4)	2	
-60	586-149	∴		. PAD, Mounting, Integrated Circuit	3	
-61	503-054			. WASHER, Nylon, #2	14	
-62	1363640-01			. INSULATOR, Relay	1	
-63	280-998	∴		. PAD, Transistor Mounting	2	
-64	280-130	∴		. PAD, Transistor Mounting	6	
-65	014-783	∴		. PAD, Transistor Mounting	3	
-66	1361593-02			. PRINTED WIRING BOARD	1	

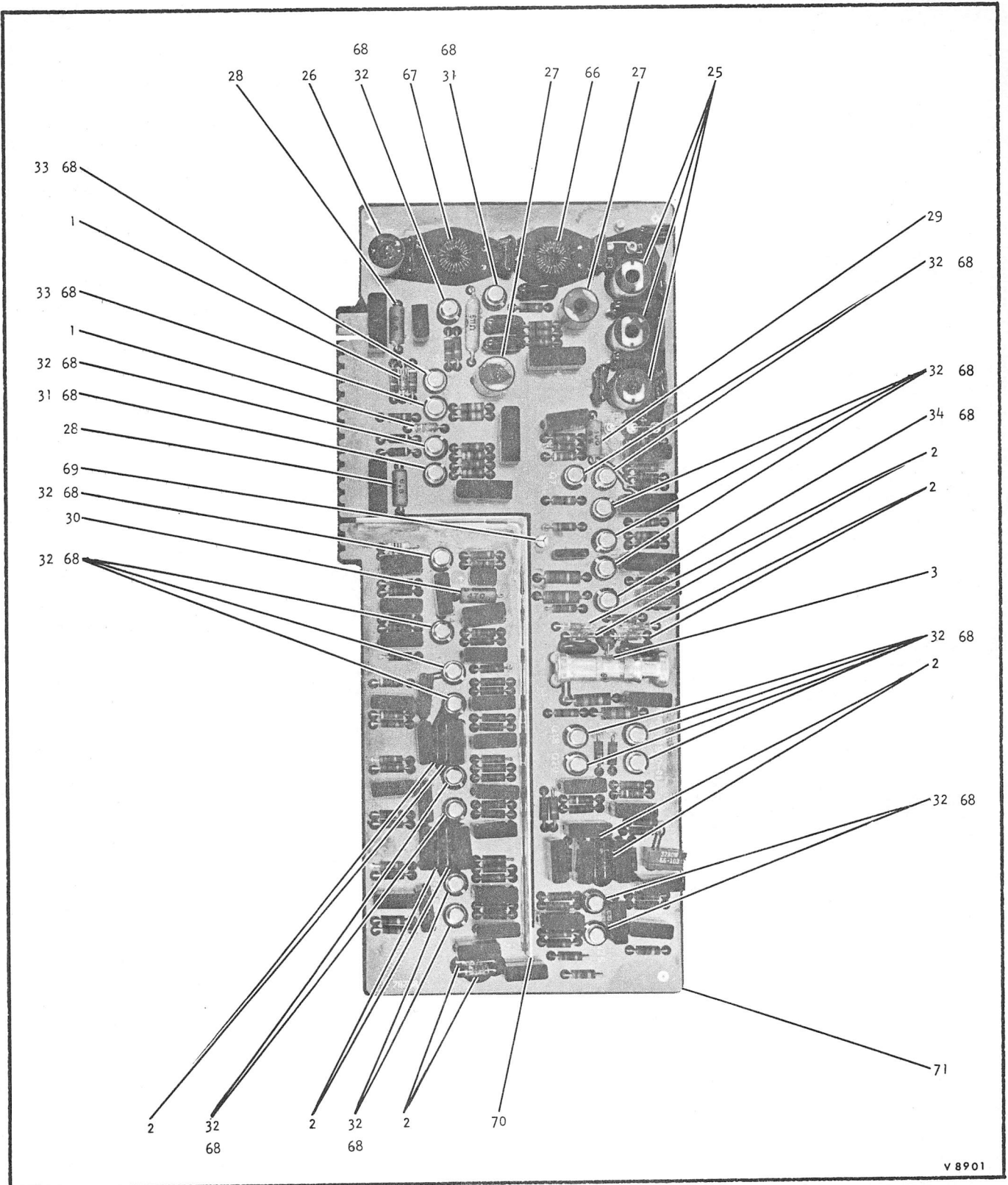


Figure 11-20. Demodulator Filter Amplifier (Board 23) (Sheet 1 of 4)

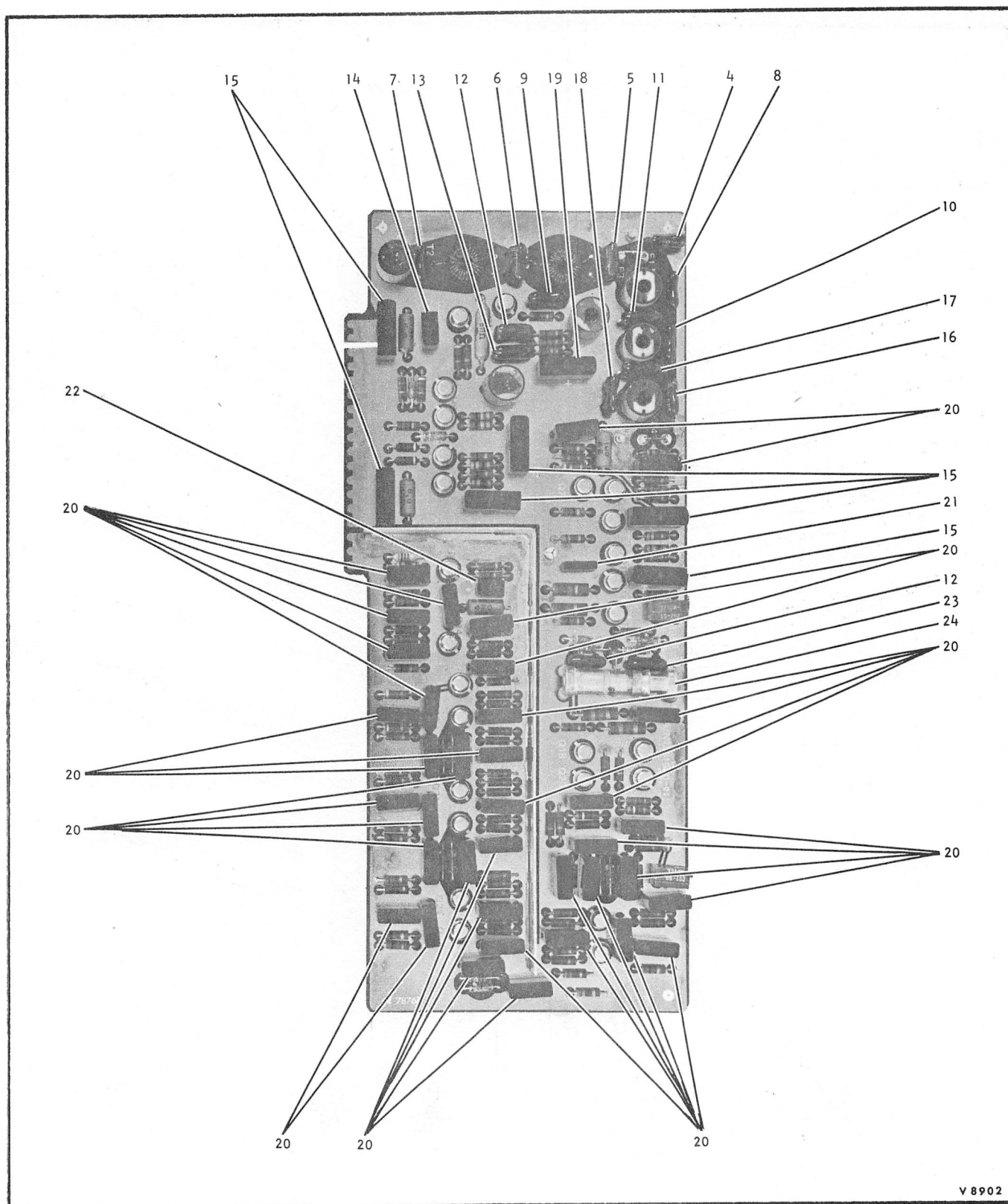


Figure 11-20. Demodulator Filter Amplifier (Board 23) (Sheet 2 of 4)

11-87

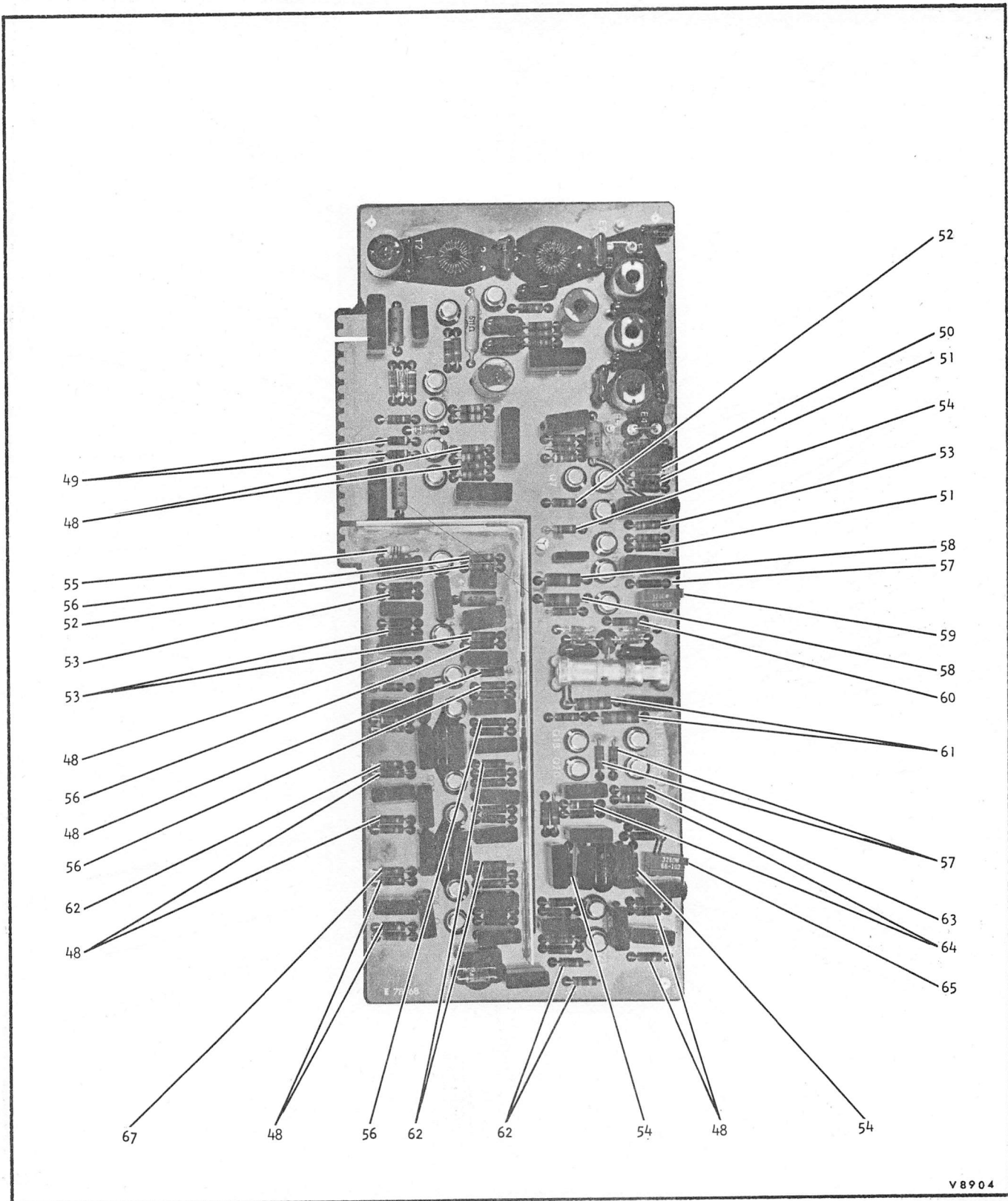


Figure 11-20. Demodulator Filter Amplifier (Board 23) (Sheet 4 of 4)

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
20	1361580-01			DEMODULATOR/FILTER AMPLIFIER (See Figure 2-15 For . . . Next Higher Assembly)	Ref	
-1	013-689			. DIODE (CR1, 2)	2	
-2	013-723	∴		. DIODE (CR3-6, 8-15)	12	
-3	013-455	∴		. DIODE (1N3716) (CR7)	1	
-4	056-273			. CAPACITOR, Mica, 77.2PF, 500V, 2% (C1)	1	
-5	034-359			. CAPACITOR, Mica, 33PF, 500V, 2% (C2)	1	
-6	056-272			. CAPACITOR, Mica, 41PF, 500V, 2% (C3)	1	
-7	056-278			. CAPACITOR, Mica, 426PF, 500V, 2% (C4)	1	
-8	034-360			. CAPACITOR, Mica, 24PF, 500V, ±1/2PF (C5)	1	
-9	056-279			. CAPACITOR, Mica, 510PF, 500V, 2% (C6)	1	
-10	056-271			. CAPACITOR, Mica, 31.1PF, 500V, 2% (C7)	1	
-11	056-277			. CAPACITOR, Mica, 216PF, 500V, 2% (C8)	1	
-12	034-416			. CAPACITOR, Mica, 100PF, 500V, 2% (C9, 31)	2	
-13	034-350			. CAPACITOR, Mica, 560PF, 300V, 2% (C10)	1	
-14	037-463			. CAPACITOR, Tantalum, 4.7μF, 35V, 10% (C11)	1	
-15	037-436			. CAPACITOR, Tantalum 47μF, 25V, 10% (C12, 18, 20-23)	6	
-16	056-022			. CAPACITOR, Mica, 6.8PF, 500V, ±1/2PF (C13)	1	
-17	056-276			. CAPACITOR, Mica, 185PF, 500V, 2% (C14)	1	
-18	056-275			. CAPACITOR, Mica, 92PF, 500V, 2% (C15)	1	
-19	037-426			. CAPACITOR, Tantalum, 82μF, 15V, 10% (C16)	1	
-20	035-837			. CAPACITOR, Mylar, 0.1μF, 50V, 10% (C17, 19, 26-29, ... 32, 33, 35-63)	37	
-21	035-840			. CAPACITOR, Mylar, 0.01μF, 50V, 10% (C24)	1	
-22	037-519			. CAPACITOR, Tantalum, 1μF, 35V, 20% (C25)	1	
-23	056-274			. CAPACITOR, Mica, 82PF, 500V, 2% (C30)	1	
-24	038-115			. CAPACITOR, Variable, 1-42PF, 1000V (C34)	1	
-25	051-166	∴		. INDUCTOR (L1, 4, 6)	3	
-26	051-334	∴		. INDUCTOR (L2)	1	
-27	041-080	∴		. INDUCTOR (L3, 7)	2	
-28	540-052	∴		. INDUCTOR (L5, 9)	2	
-29	540-006	∴		. INDUCTOR (L8)	1	
-30	540-007	∴		. INDUCTOR (L10)	1	
-31	014-505	∴		. TRANSISTOR, (Q1, 8)	2	
-32	014-506	∴		. TRANSISTOR (Q2, 5-7, 9-12, 14-26)	21	
-33	014-354	∴		. TRANSISTOR (2N709) (Q3, 4)	2	
-34	014-581	∴		. TRANSISTOR (Q13)	1	
-35	041-569			. RESISTOR, Carbon Composition, 300 Ohm, 1/4W, 5% (R1)	1	
-36	041-419			. RESISTOR, Carbon Composition, 100 Ohm, 1/4W, 5% (R2, 3, ... 23, 37, 41, 43, 51, 54, 57, 58, 65, 69, 73, 75, 84, 88, 91, 93, 94)	20	
-37	041-406			. RESISTOR, Carbon Composition, 22000 Ohm, 1/4W, 5% (R4)	1	
-38	048-621			. RESISTOR, Metal Film 511 Ohm 1/2W, 1% (R5)	1	
-39	041-414			. RESISTOR, Carbon Composition, 2200 Ohm, 1/4W, 5% (R6, ... 63, 70-72, 76, 77, 83, 89, 90, 95)	11	
-40	041-425			. RESISTOR, Carbon Composition, 47 Ohm, 1/4W, 5% (R7)	1	
-41	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, 5% (R8, 50, 56)	3	
-42	041-738			. RESISTOR, Carbon Composition, 160 Ohm, 1/4W, 5% (R9, 12)	2	
-43	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, 5% (410, 11)	2	
-44	041-651			. RESISTOR, Carbon Composition, 33 Ohm, 1/4W, 5% (R13, ... 18, 25, 29, 33)	5	
-45	041-442			. RESISTOR, Carbon Composition, 2700 Ohm, 1/4W, 5% (R14)	1	
-46	041-437			. RESISTOR, Carbon Composition, 1600 Ohm, 1/4W, 5% (R15)	1	
-47	041-743			. RESISTOR, Carbon Composition, 430 Ohm 1/4W, 5% (R16)	1	
-48	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, 5% (R17, ... 24, 47, 48, 64, 74, 85, 87, 92, 96)	10	

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1809993

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
20-49	057-076			. RESISTOR, Metal Film, 150, 1/4W, 20% (R19, 20)	2	
-50	041-429			. RESISTOR, Carbon Composition, 680 Ohm, 1/4W, 5% (R21) . . .	1	
-51	041-744			. RESISTOR, Carbon Composition, 1300 Ohm, 1/4W, 5% (R22, 30)	2	
-52	041-647			. RESISTOR, Carbon Composition, 75 Ohm, 1/4W, 5% (R26, 34). .	2	
-53	041-427			. RESISTOR, Carbon Composition, 330 Ohm, 1/4W, 5% (R27, 38, 44, 45)	4	
-54	041-407			. RESISTOR, Carbon Composition, 3300 Ohm, 1/4W, 5% (R28, 79, 80)	3	
-55	057-083			. RESISTOR, Metal Film, 300 Ohm, 1/4W, 2% (R31)	1	
-56	041-440			. RESISTOR, Carbon Composition, 1200 Ohm, 1/4W, 5% (R32, 46, 49, 55)	4	
-57	041-503			. RESISTOR, Carbon Composition, 270 Ohm, 1/4W, 5% (R35, 59, 60)	3	
-58	041-317			. RESISTOR, Carbon Composition, 820 Ohm, 1/2W, 5% (R36, 40)	2	
-59	058-328			. RESISTOR, Variable, 2000 Ohm, 1/2W, 5% (R39)	1	
-60	041-506			. RESISTOR, Carbon Composition, 820 Ohm, 1/4W, 5% (R42) . . .	1	
-61	041-256			. RESISTOR, Carbon Composition, 560 Ohm, 1/2W, 5% (R52, 53)	2	
-62	041-413			. RESISTOR, Carbon Composition, 6800 Ohm, 1/4W, 5% (R61, 62, 81, 82, 97, 98)	6	
-63	041-739			. RESISTOR, Carbon Composition, 180 Ohm, 1/4W, 5% (R66) . . .	1	
-64	041-417			. RESISTOR, Carbon Composition, 390 Ohm, 1/4W, 5% (R67, 68)	2	
-65	058-322			. RESISTOR, Variable, 10000 Ohm, 1/2W, 5% (R78)	1	
-66	1380190-01			. INDUCTOR (T1)	1	
-67	1380190-02			. INDUCTOR (T2)	1	
-68	280-100	∴		. PAD, Transistor Mounting	26	
-69	251-091	∴		. BUTTON, Plug	1	
-70	1363338-01			. SHIELD	1	
-71	1361581-02			. PRINTED WIRING BOARD	1	

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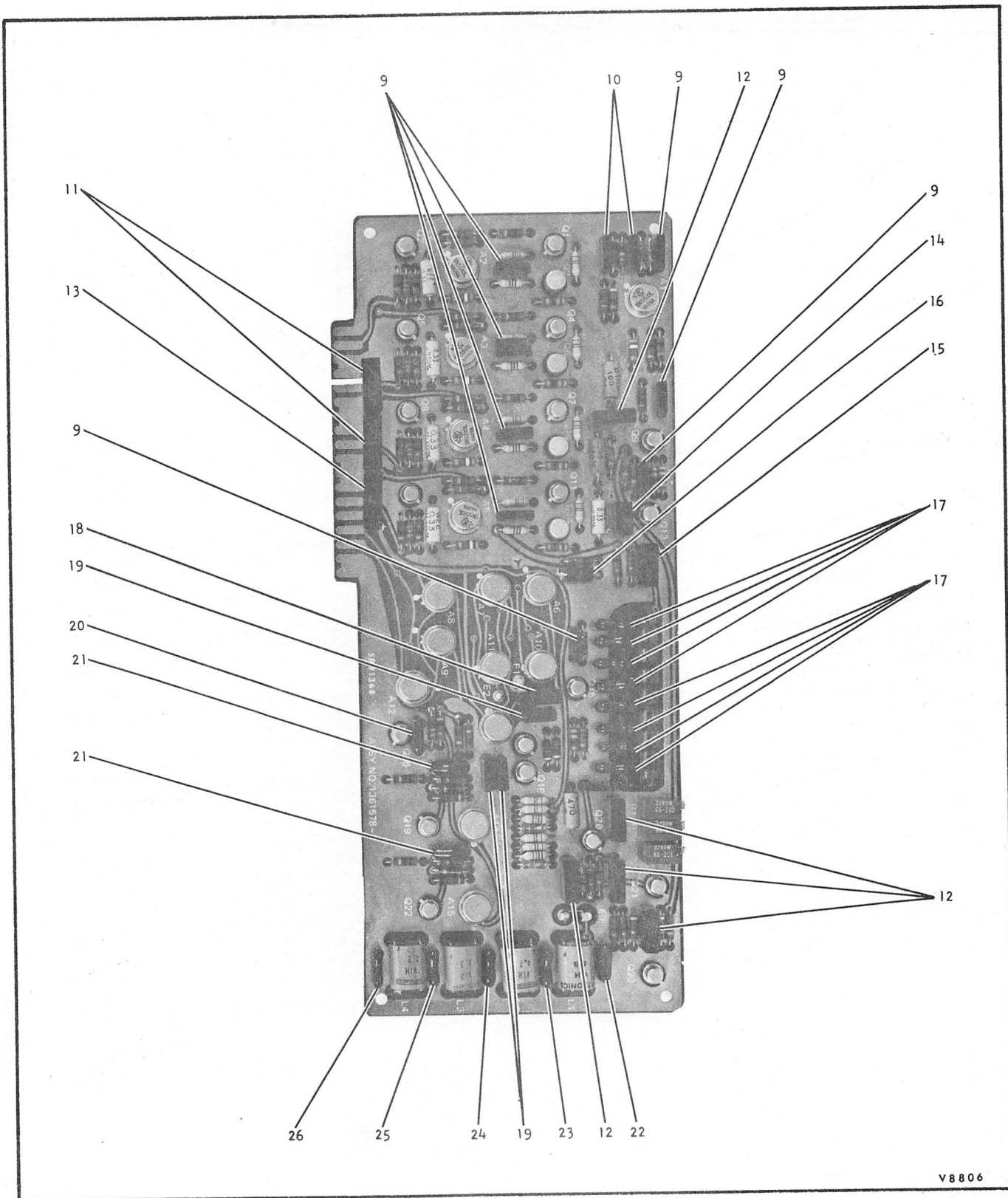


Figure 11-21. Switcher/Equalizer (Board 22) (Sheet 2 of 4)

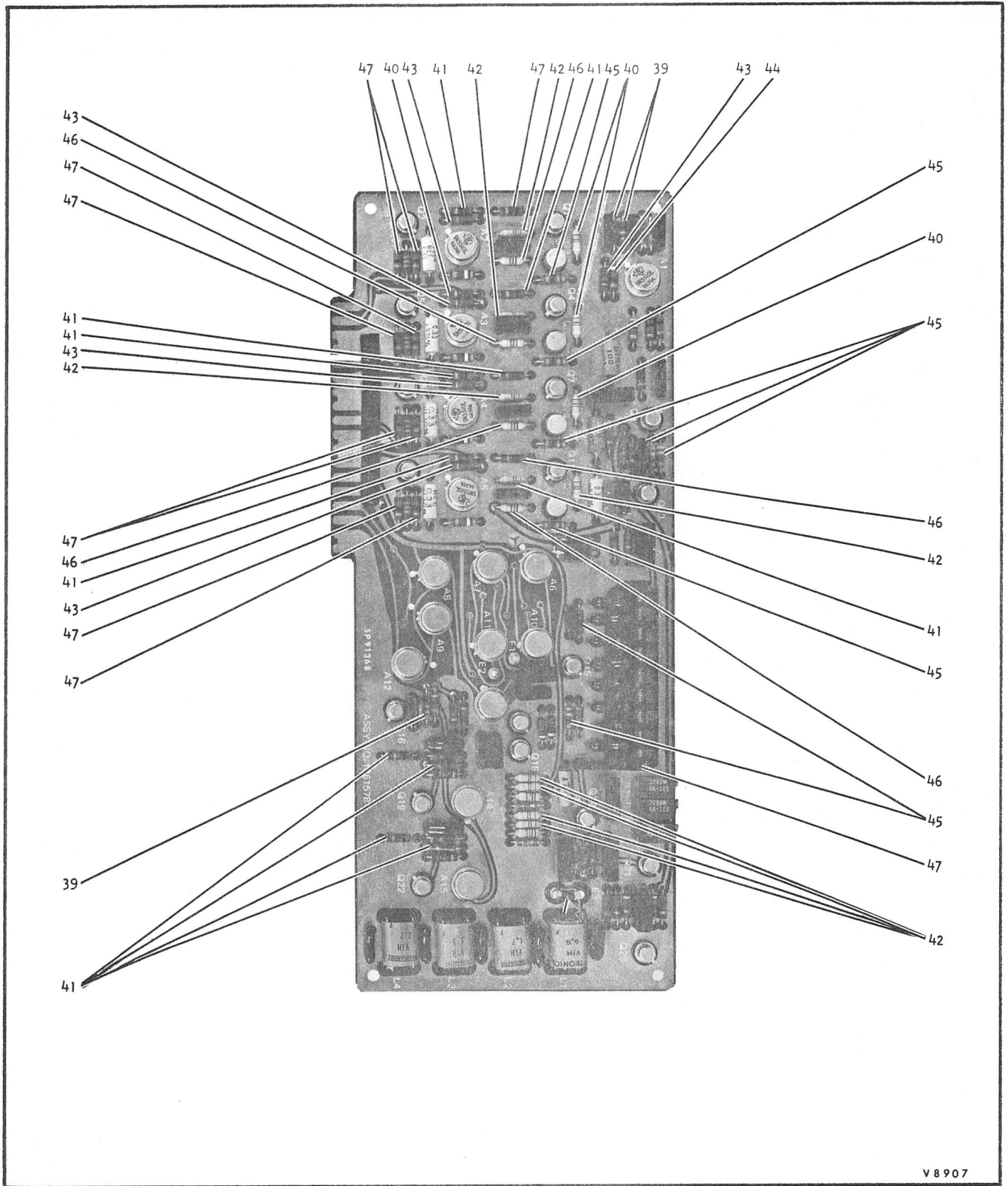


Figure 11-21. Switcher/Equalizer (Board 22) (Sheet 3 of 4)

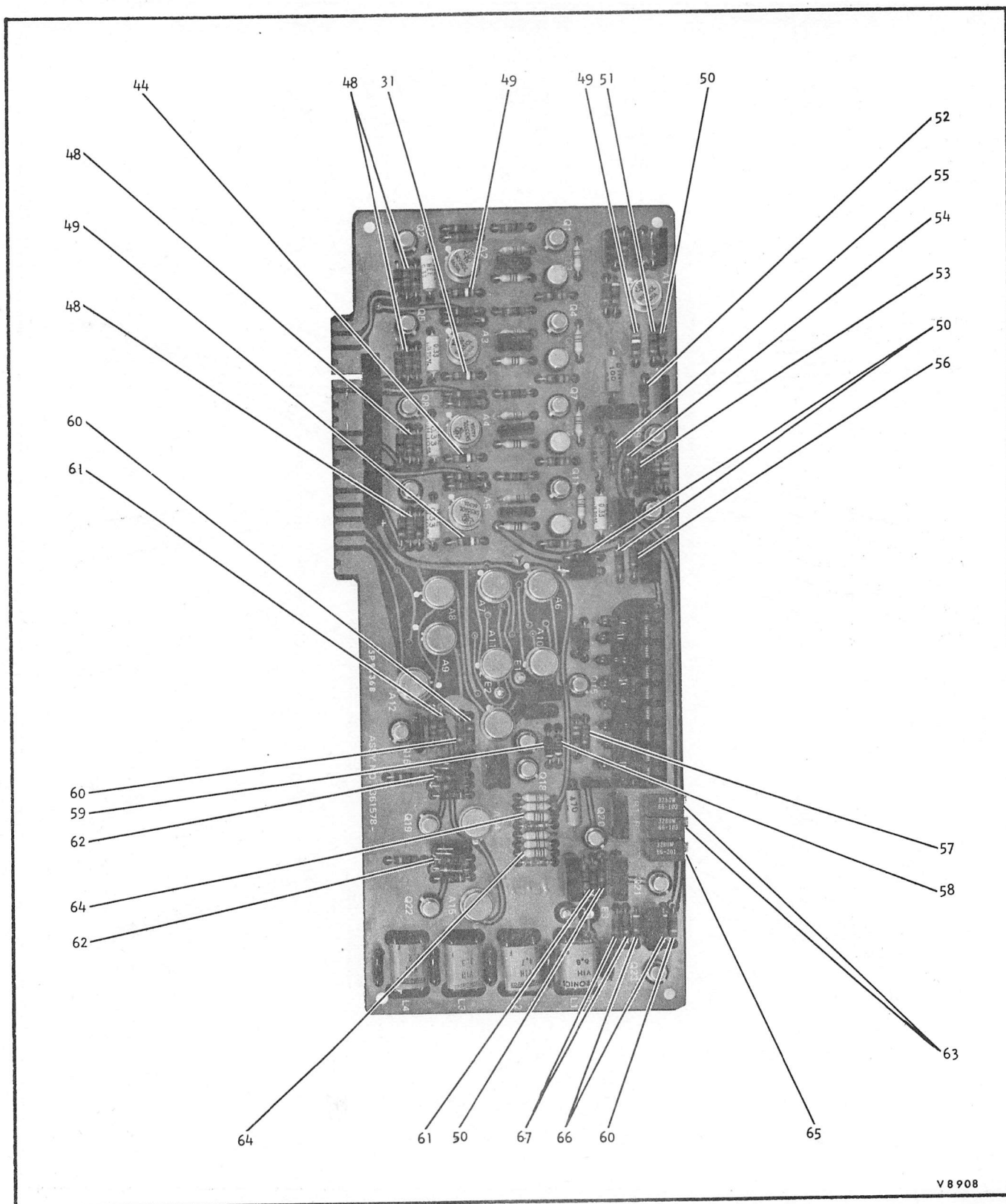


Figure 11-21. Switcher/Equalizer (Board 22) (Sheet 4 of 4)

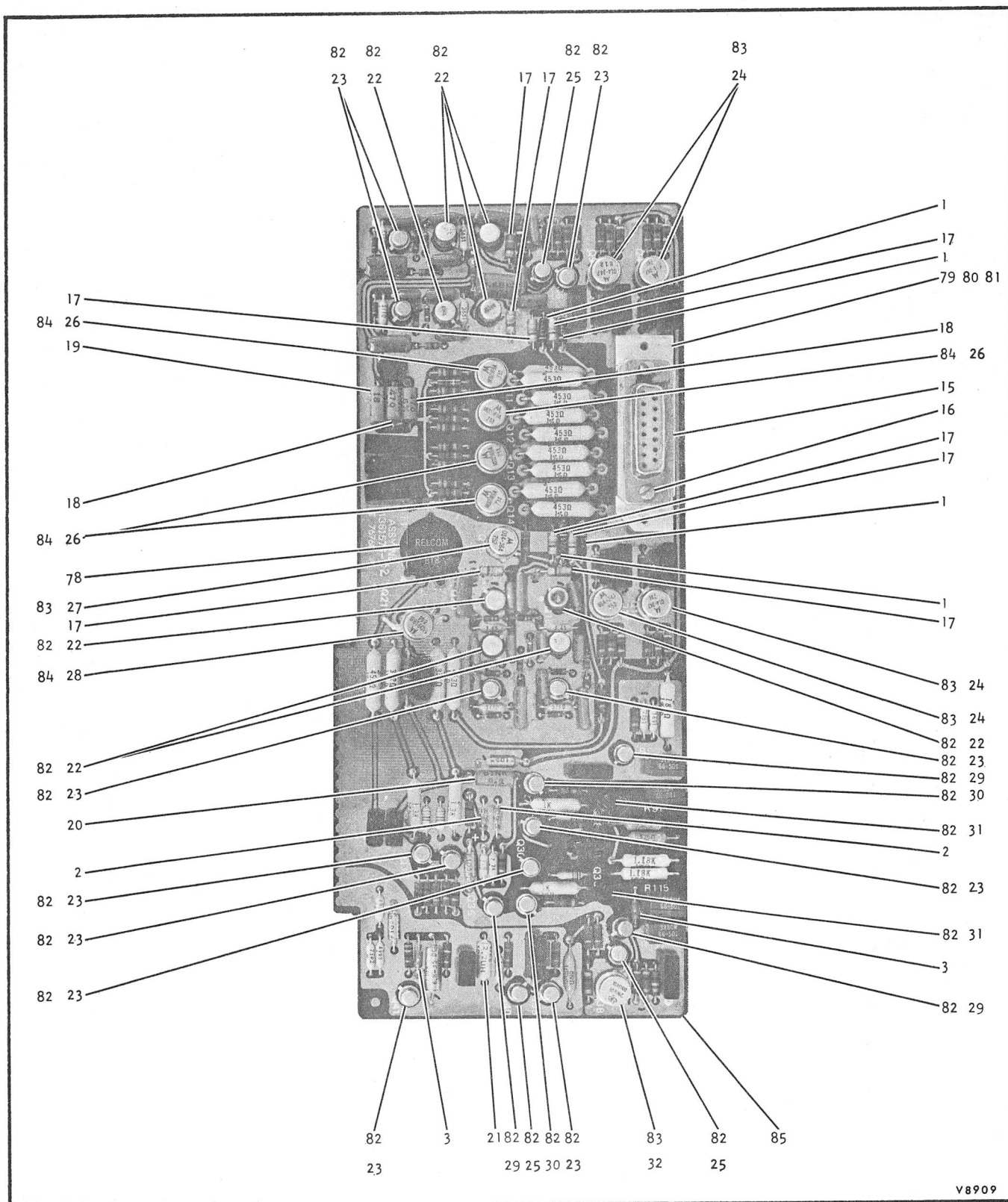
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1809993

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
21	1361578-01			SWITCHER EQUALIZER (See Figure 2-16 For Next Higher Assembly	Ref	
-1	586-162	∴		. CIRCUIT, Integrated (A1-5)	5	
-2	586-021	∴		. CIRCUIT, Integrated (A6, 7)	2	
-3	586-019	∴		. CIRCUIT, Integrated (A8, 10, 11)	3	
-4	586-052	∴		. CIRCUIT, Integrated (A9)	1	
-5	586-051	∴		. CIRCUIT, Integrated (A12, 13)	2	
-6	586-060	∴		. CIRCUIT, Integrated (A14, 15)	2	
-7	013-723	∴		. DIODE (CR1, 2)	2	
-8	013-689	∴		. DIODE (CR3, 4)	2	
-9	035-840			. CAPACITOR, Mylar, 0.01μF, 50V, 10% (C1, 4, 5, 7, 9, 11, . . . 14, 19, 32)	9	
-10	035-844			. CAPACITOR, Mylar, 0.001μF, 50V, 10% (C2, 3)	2	
-11	037-436			. CAPACITOR, Tantalum, 47μF, 25V, 10% (C6, 10)	2	
-12	035-837			. CAPACITOR, Mylar, 0.1μF, 50V, 10% (C8, 33-35, 37)	5	
-13	037-426			. CAPACITOR, Tantalum, 82μF, 15V, 10% (C12)	1	
-14	037-476			. CAPACITOR, Tantalum, 10μF, 25V, 10% (C13)	1	
-15	035-854			. CAPACITOR, Mylar, 0.068μF, 50V, 10% (C15)	1	
-16	037-463			. CAPACITOR, Tantalum, 4.7μF, 35V, 10% (C16)	1	
-17	034-788			. CAPACITOR, Mica, 27PF, 500V, 2% (R17, 18, 20, 21, ... 23, 25, 27, 28)	8	
-18	035-598			. CAPACITOR, Mylar, 0.047μF, 50V, 5% (C22)	1	
-19	035-817			. CAPACITOR, Mylar, 0.015μF, 50V, 5% (C24, 29, 30)	3	
-20	034-930			. CAPACITOR, Mica, 680PF, 300V, 5% (C26)	1	
-21	034-350			. CAPACITOR, Mica, 560PF, 300V, 2% (C31, 36)	2	
-22	034-297			. CAPACITOR, Mica 180PF, 500V, 1% (C38)	1	
-23	034-343			. CAPACITOR, Mica, 68PF, 500V, 2% (C39)	1	
-24	034-248			. CAPACITOR, Mica, 50PF, 500V, 1% (C40)	1	
-25	034-327			. CAPACITOR, Mica, 30PF, 500V, 2% (C41)	1	
-26	034-156			. CAPACITOR, Mica, 5PF, 500V, ±5PF (C42)	1	
-27	1212228-01			. INDUCTOR, Delay Line (DL1)	1	
-28	540-077	∴		. INDUCTOR, 0.33μH, 20% (L1, 2, 4, 6, 7)	5	
-29	540-006	∴		. INDUCTOR, 100μH, 5% (L3)	1	
-30	540-014	∴		. INDUCTOR, 15μH, 10% (L5)	1	
-31	540-007	∴		. INDUCTOR, 470μH, 5% (L8)	1	
-32	051-484	∴		. INDUCTOR, 27μH, 5% (L9)	1	
-33	051-386	∴		. INDUCTOR, Adjustable, 6.8μH, 20% (L10)	1	
-34	051-369	∴		. INDUCTOR, Adjustable, 4.7μH, 20% (L11)	1	
-35	051-334	∴		. INDUCTOR, Adjustable, 3.3μH, 20% (L12)	1	
-36	051-363	∴		. INDUCTOR, Adjustable, 2.2μH, 20% (L13)	1	
-37	014-506	∴		. TRANSISTOR (Q1, 2, 4, 5, 7-9, 11-13, 15-23)	19	
-38	1241512-01			. TRANSISTOR (Ampex Specification Drawing) (Q3, 6, 10, 14)	4	
-39	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, 5% (R1, 2, 69)	3	
-40	057-082			. RESISTOR, Metal Film, 270 Ohm, 1/4W, 2% (R3, 22, 34, 50)	4	
-41	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, 5% (R4, 6, . . . 16, 17, 30, 32, 43, 48, 71, 72, 86, 87)	12	
-42	057-106			. RESISTOR, Metal Film, 2700 Ohm, 1/4W, 2% (R5, 23, 35, 51, . . . 75, 76, 80, 81)	8	
-43	041-531			. RESISTOR, Carbon Composition, 750 Ohm, 1/4W, 5% (R7, 9, . . . 18, 33, 49)	5	
-44	041-425			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, 5% (R8)	1	
-45	041-651			. RESISTOR, Carbon Composition, 33 Ohm, 1/4W, 5% (R10, 29, . . . 36, 37, 41, 56, 61, 63)	8	
-46	057-119			. RESISTOR, Metal Film, 9100 Ohm, 1/4W, 2% (R11, 24, 42, 52)	4	
-47	041-554			. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, 5% (R12, 14, . . . 25, 27, 45, 47, 53, 55, 73)	9	
-48	041-684			. RESISTOR, Carbon Composition, 5.6 Ohm, 1/4W, 5% (R13, 26, 46, 54)	4	

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
21-49	041-417			. RESISTOR, Carbon Composition, 390 Ohm, 1/4W, 5% (R15, 21, 31, 44, 57)	5	
-50	041-419			. RESISTOR, Carbon Composition, 100 Ohm, 1/4W, 5% (R19, 59, 60, 83)	4	
-51	041-740			. RESISTOR, Carbon Composition, 200 Ohm, 1/4W, 5% (R20)	1	
-52	041-440			. RESISTOR, Carbon Composition, 1200 Ohm, 1/4W, 5% (R28)	1	
-53	041-537			. RESISTOR, Carbon Composition, 82 Ohm, 1/4W, 5% (R38)	1	
-54	041-973			. RESISTOR, Carbon Composition, 1100 Ohm, 1/4W, 5% (R39)	1	
-55	041-503			. RESISTOR, Carbon Composition, 270 Ohm, 1/4W, 5% (R40)	1	
-56	041-738			. RESISTOR, Carbon Composition, 160 Ohm, 1/4W, 5% (R58)	1	
-57	041-429			. RESISTOR, Carbon Composition, 680 Ohm, 1/4W, 5% (R62)	1	
-58	057-132			. RESISTOR, Metal Film, 33000 Ohm, 1/4W, 2% (R64)	1	
-59	057-125			. RESISTOR, Metal Film, 16000 Ohm, 1/4W, 2% (R65)	1	
-60	041-506			. RESISTOR, Carbon Composition, 820 Ohm, 1/4W, 5% (R66, 67, 88)	3	
-61	041-569			. RESISTOR, Carbon Composition, 300 Ohm, 1/4W, 5% (R68, 84)	2	
-62	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, 5% (R70, 85)	2	
-63	058-322			. RESISTOR, Variable, Wirewound, 10000 Ohm, 1W, 5% (R74, 78)	2	
-64	057-122			. RESISTOR, Metal Film, 12000 Ohm, 1/4W, 2% (R77, 82)	2	
-65	058-319			. RESISTOR, Variable, Wirewound, 200 Ohm, 1W, 5% (R79)	1	
-66	041-412			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, 5% (R89, 90)	2	
-67	041-647			. RESISTOR, Carbon Composition, 75 Ohm, 1/4W, 5% (R91, 92)	2	
-68	013-257	..		. DIODE (VR1, 2)	2	
-69	586-160	..		. PAD, Mounting, Integrated Circuit	12	
-70	586-149	..		. PAD, Mounting, Integrated Circuit	3	
-71	280-100	..		. PAD, Transistor Mounting	23	
-72	251-091	..		. PLUG, Button	1	
-73	1361579-02			. PRINTED WIRING BOARD	1	



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Figure 11-22. Modulator Preamplifier (Board 21) (Sheet 1 or 4)

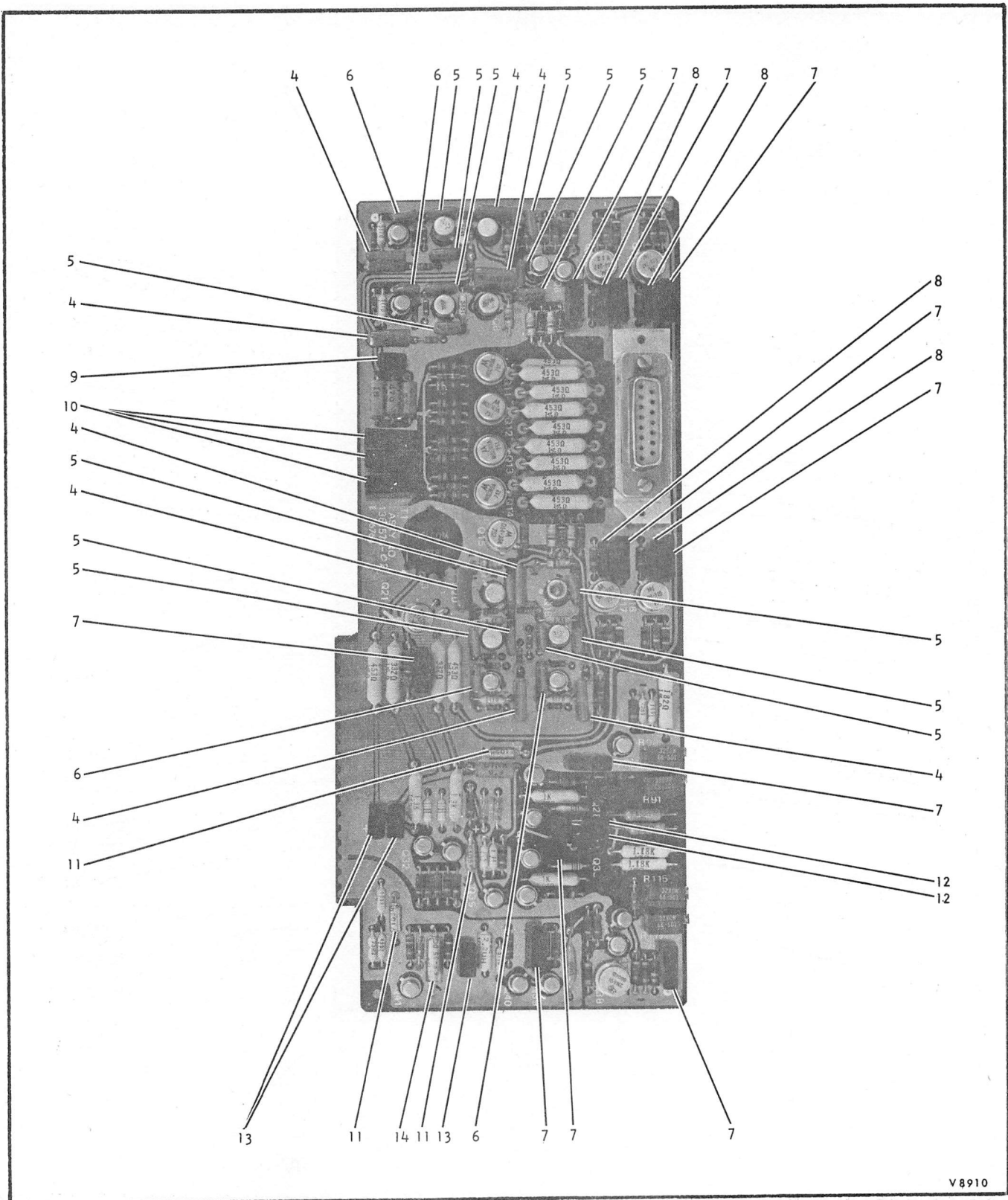


Figure 11-22. Modulator Preamplifier (Board 21) (Sheet 2 of 4)

V8911

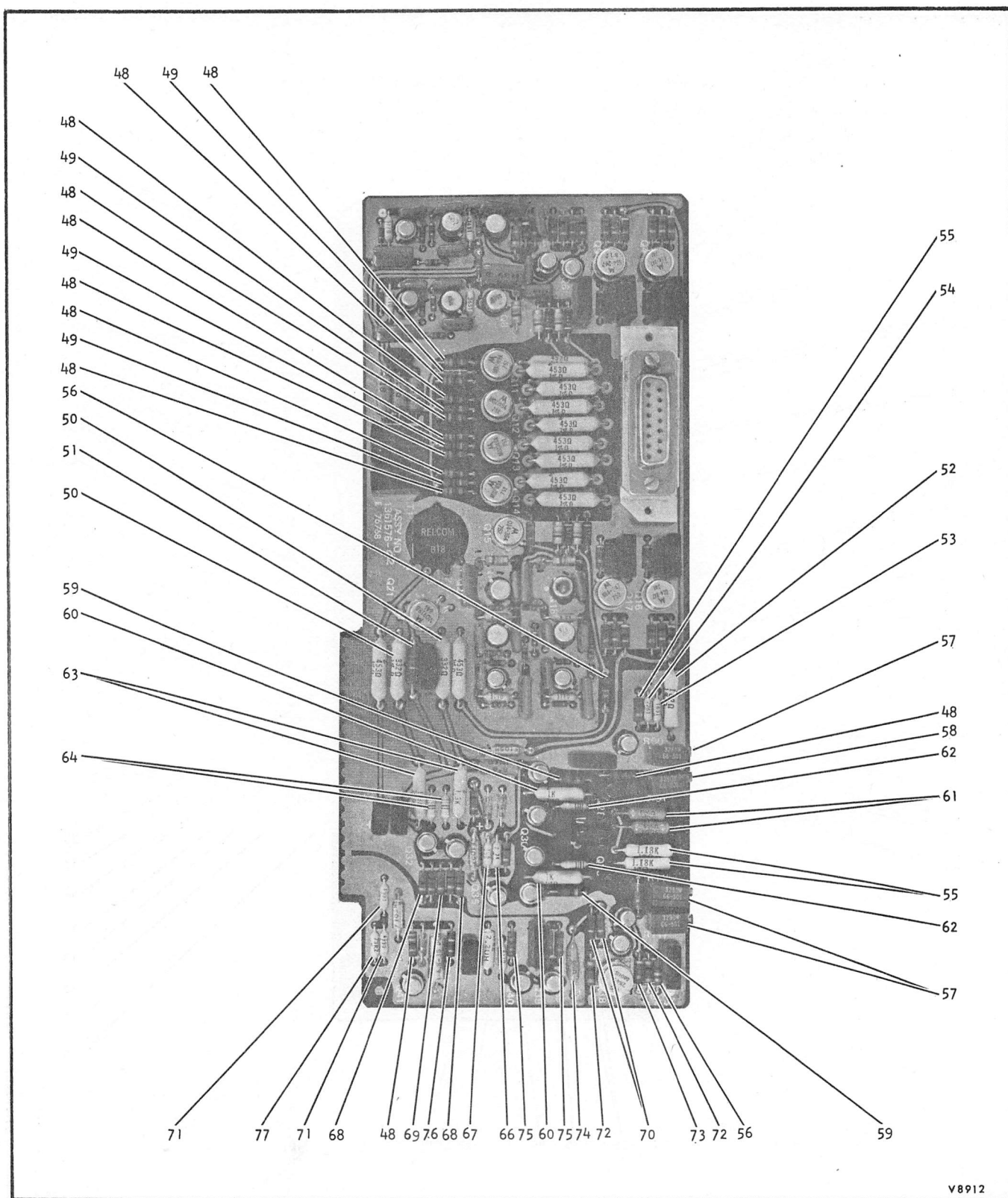


Figure 11-22. Modulator Preamplifier (Board 21) (Sheet 4 of 4)

PRINTED WIRING ASSEMBLY

1809993

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
22	1361576-02			MODULATOR/PRE AMPLIFIER (See Figure 2-17 For Next Higher Assembly)	Ref	
-1	013-677	∴		. DIODE (CR1-4)	4	
-2	013-723	∴		. DIODE (CR5,6)	2	
-3	013-689			. DIODE (CR7,8)	2	
-4	030-451			. CAPACITOR, Ceramic, 0.68μF, 25V, 20% (C1,6,18,28,30, . . 35,37)	8	
-5	030-212			. CAPACITOR, Ceramic, 0.01μF, 25V, 20% (C2,4,5,7,9,16, . . 17,27,29,31-34)	13	
-6	030-224			. CAPACITOR, Ceramic, 0.1μF, 25V, 20% (C3,10,36,38)	4	
-7	035-883			. CAPACITOR, Mylar, 0.068μF, 50V, 5% (C11,13,15,23, ... 25,39,41,44,49,50)	10	
-8	035-840			. CAPACITOR, Mylar, 0.01μF, 50V, 10% (C12,14,24,26)	4	
-9	037-519			. CAPACITOR, Tantalum, 1μF, 35V, 20% (C19)	1	
-10	037-436			. CAPACITOR, Tantalum, 47μF, 25V, 10% (C20-22)	3	
-11	037-058			. CAPACITOR, Tantalum, 1μF, 35V, 20% (C40,47,48)	3	
-12	034-571			. CAPACITOR, Mica, 36PF, 500V, 20% (C42,43)	2	
-13	037-463			. CAPACITOR, Tantalum, 4.7μF, 35V, 10% (C45,46,51)	3	
-14	037-071			. CAPACITOR, Tantalum, 6.8μF, 35V, 20% (C52)	1	
-15	146-020	∴		. CONNECTOR, Receptacle, Electrical (J1)	1	
-16	472-454			. SCREW, Machine, Pan Head, Xrecess, 2-56 x 3/8 Lg (AP) . . .	2	
-17	051-411	∴		. INDUCTOR, 470μH, 10% (L1-4, 8-11)	8	
-18	540-007	∴		. INDUCTOR, 470μH, 5% (L5,6)		
-19	540-041	∴		. INDUCTOR, 18μH, 10% (L7)	1	
-20	540-052	∴		. INDUCTOR, 6.8μH, 10% (L12)	1	
-21	540-009	∴		. INDUCTOR, 2.2μH, 10% (L13)	1	
-22	1241512-01			. TRANSISTOR (Ampex Specification Drawing) (A1,2,8,9,18, . . . 19,22,23)	8	
-23	014-506	∴		. TRANSISTOR (Q3,6,10,24,25,29-32,39,41)	11	
-24	014-247	∴		. TRANSISTOR (Q4,5,16,17)	4	
-25	014-505	∴		. TRANSISTOR (Q7,37,40)	3	
-26	014-852	∴		. TRANSISTOR (Q11-14)	4	
-27	014-364	∴		. TRANSISTOR (Q15)	1	
-28	014-850	∴		. TRANSISTOR (Q20)	1	
-29	014-248	∴		. TRANSISTOR (Q26,35,36)	3	
-30	014-354	∴		. TRANSISTOR (2N709) (Q27,34)	2	
-31	014-353	∴		. TRANSISTOR (2N2402) (Q28,33)	2	
-32	014-057	∴		. TRANSISTOR (2N491) (Q38)	1	
-33	041-425			. RESISTOR, Carbon Composition, 47 Ohm, 1/4W, 5% (R1,4, . . 21,22,58,59,64,67)	8	
-34	041-419			. RESISTOR, Carbon Composition, 100 Ohm, 1/4W, 5% (R2,5, . . 65,68,127)	5	
-35	041-560			. RESISTOR, Carbon Composition, 2000 Ohm, 1/4W, 5% (R3, . . 6,66,69,98,111,113)	7	
-36	041-410			. RESISTOR, Carbon Composition, 1000 Ohm, 1/4W, 5% (R7, . . 9,106)	3	
-37	041-413			. RESISTOR, Carbon Composition, 6800 Ohm, 1/4W, 5% (R8, . . 10,57)	3	
-38	041-495			. RESISTOR, Carbon Composition, 8200 Ohm, 1/4W, 5% (R11) . .	1	
-39	041-511			. RESISTOR, Carbon Composition, 3900 Ohm, 1/4W, 5% (R12) . .	1	
-40	049-408			. RESISTOR, Carbon Composition, 12000 Ohm, 1/8W, 5% (R13,19,61,62)	4	
-41	056-288			. RESISTOR, Metal Film, 3650 Ohm, 1/10W, 1% (R14,23,60,63) .	4	
-42	049-402			. RESISTOR, Carbon Composition, 47 Ohm, 1/8W, 5% (R15, . . . 24,70,74)	4	
-43	049-405			. RESISTOR, Carbon Composition, 2000 Ohm, 1/8W, 5% (R16, . . 25,72,75)	4	
-44	056-284			. RESISTOR, Metal Film, 511 Ohm, 1/10W, 1% (R17,26, ... 86,88,129)	5	

PRINTED WIRING ASSEMBLY

1809993

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
22-45	049-404			. RESISTOR, Carbon Composition, 510 Ohm, 1/8W, 5% (R18, . . . 27, 87, 89)	4	
-46	049-401			. RESISTOR, Carbon Composition, 43 Ohm, 1/8W, 5% (R20, . . . 28, 71, 73)	4	
-47	042-809			. RESISTOR, Metal Film, 453 Ohm, 1/2W, 1% (R29-32, ... 36-39, 43-46, 50-53, 76, 80)	18	
-48	041-651			. RESISTOR, Carbon Composition, 33 Ohm, 1/4W, 5% (R33, . . . 35, 40, 42, 47, 49, 54, 56, 92, 131)	10	
-49	041-496			. RESISTOR, Carbon Composition, 10 Ohm, 1/4W, 5% (R34, . . . 41, 48, 55)	4	
-50	048-875			. RESISTOR, Metal Film, 332 Ohm, 1/2W, 1% (R77, 79)	2	
-51	041-461			. RESISTOR, Carbon Composition, 180 Ohm, 1/2W, 5% (R78) . . .	1	
-52	048-943			. RESISTOR, Metal Film 182 Ohm, 1/2W, 1% (R81)	1	
-53	056-285			. RESISTOR, Metal Film 1690 Ohm, 1/10W, 1% (R82)	1	
-54	056-286			. RESISTOR, Metal Film 2260 Ohm, 1/10W, 1% (R83)	1	
-55	041-396			. RESISTOR, Carbon Composition, 220 Ohm, 1/4W, 5% (R84) . . .	1	
-56	041-408			. RESISTOR, Carbon Composition, 10000 Ohm, 1/4W, 5% (R85, 121)	2	
-57	058-266			. RESISTOR, Variable, Wirewound, 500 Ohm, 1W, 5% (R90, . . . 115, 117)	3	
-58	058-319			. RESISTOR, Variable, Wirewound, 200 Ohm, 1W, 5% (R91) . . .	1	
-59	041-652			. RESISTOR, Carbon Composition, 27 Ohm, 1/4W, 5% (R93, 116) .	2	
-60	048-259			. RESISTOR, Metal Film, 1000 Ohm, 1/4W, 1% (R94, 109)	2	
-61	048-715			. RESISTOR, Metal Film, 536 Ohm, 1/4W, 1% (R95, 96)	2	
-62	057-072			. RESISTOR, Metal Film, 100 Ohm, 1/4W, 2% (R97, 105)	2	
-63	048-860			. RESISTOR, Metal Film, 1360 Ohm, 1/4W, 1% (R99, 102)	2	
-64	057-084			. RESISTOR, Metal Film, 330 Ohm, 1/4W, 2% (R100, 101)	2	
-65	057-977			. RESISTOR, Metal Film, 1180 Ohm, 1/4W, 1% (R103, 104) . . .	2	
-66	056-287			. RESISTOR, Metal Film, 2740 Ohm, 1/10W, 1% (R107)	1	
-67	056-281			. RESISTOR, Metal Film, 1500, 1/10W, 1% (R108)	1	
-68	041-647			. RESISTOR, Carbon Composition, 75 Ohm, 1/4W, 5% (R110, 114).	2	
-69	041-440			. RESISTOR, Carbon Composition, 1200 Ohm 1/4W, 5% (R112) . .	1	
-70	041-430			. RESISTOR, Carbon Composition, 1500 Ohm, 1/4W, 5% (R118, 119)	2	
-71	056-283			. RESISTOR, Metal Film, 499 Ohm, 1/10W, 1% (R120, 132) . . .	2	
-72	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, 5% (R122, 124)	2	
-73	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, 5% (R123) . .	1	
-74	048-499			. RESISTOR, Metal Film, 619 Ohm, 1/4W, 1% (R125)	1	
-75	041-437			. RESISTOR, Carbon Composition, 1600 Ohm, 1/4W, 5% (R126, 128)	2	
-76	041-570			. RESISTOR, Carbon Composition, 2400 Ohm, 1/4W, 5% (R130) .	1	
-77	056-282			. RESISTOR, Metal Film, 73.2 Ohm, 1/10W, 1% (R133)	1	
-78	560-295	..		. TRANSFORMER (T1)	1	
-79	1361617-01			. SPACER, Connector	1	
-80	472-454			. SCREW, Machine, Pan Head, Xrecess, 2-56 x 3/8 Lg (AP) . . .	2	
-81	501-055			. WASHER, Flat, #2 (AP)	2	
-82	280-100	..		. PAD, Transistor Mounting	29	
-83	280-998	..		. PAD, Transistor Mounting	6	
-84	014-954			. PAD, Transistor Mounting.	5	
-85	1361577-02			. PRINTED WIRING BOARD.	1	

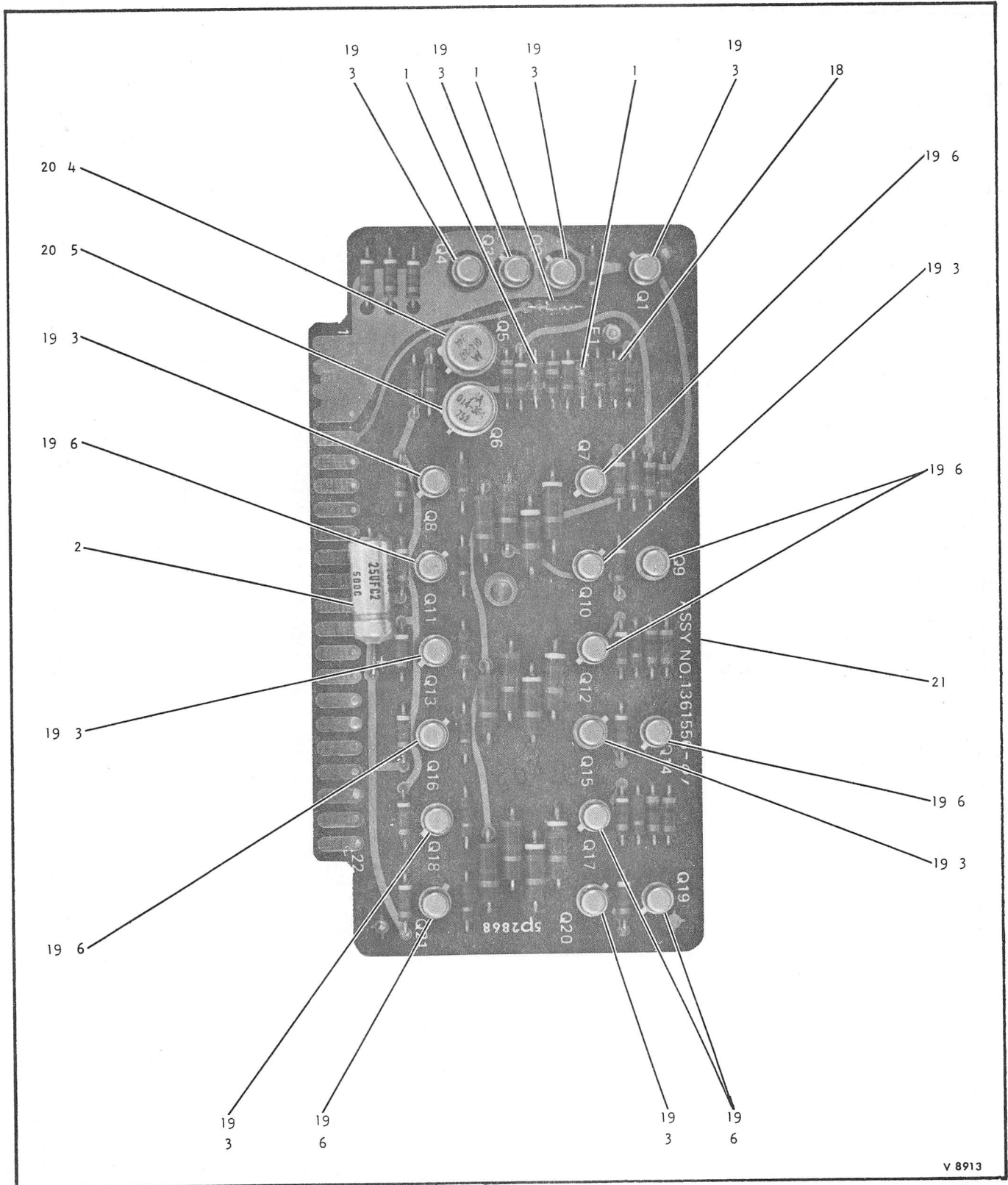
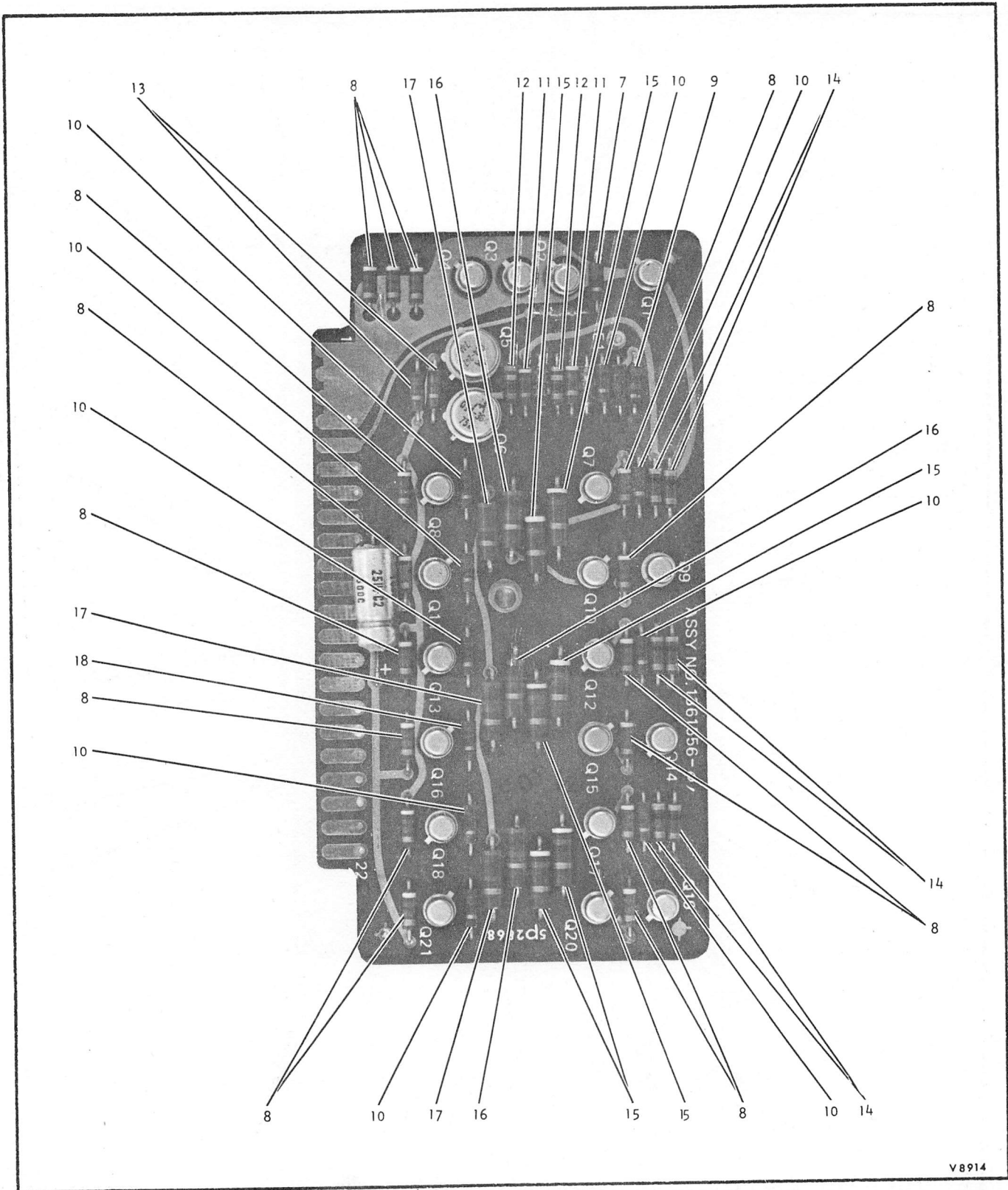


Figure 11-23. MDA Head Drum (Board 17) (Sheet 1 of 2)



V8914

Figure 11-23. MDA Head Drum (Board 17) (Sheet 2 of 2)

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
23	1361556-01			MDA HEAD DRIVE (See Figure 2-18 For Next Higher Assembly)	Ref	
-1	013-689			. DIODE (CR1-3)	3	
-2	037-222			. CAPACITOR, Tantalum, 25 μ F, 50V, +20%, -15% (C1)	1	
-3	014-248	∴		. TRANSISTOR, (Q1-4, 8, 10, 13, 15, 18, 20)	10	
-4	014-247	∴		. TRANSISTOR (Q5)	1	
-5	014-364	∴		. TRANSISTOR (Q6)	1	
-6	014-505	∴		. TRANSISTOR (Q7, 9, 11, 12, 14, 16, 17, 19, 21)	9	
-7	041-434			. RESISTOR, Carbon Composition, 1800 Ohm, 1/4W, 5% (R1) . . .	1	
-8	041-428			. RESISTOR, Carbon Composition, 470 Ohm, 1/4W, 5% (Q2-4, . . 16, 22, 23, 25, 29, 35, 36, 38, 42, 48, 49, 51)	15	
-9	041-419			. RESISTOR, Carbon Composition, 100 Ohm, 1/4W, 5% (R5) . . .	1	
-10	041-414			. RESISTOR, Carbon Composition, 2200 Ohm, 1/4W, 5% (R6, 15, 21, 24, 28, 34, 37, 41, 47, 50)	10	
-11	041-412			. RESISTOR, Carbon Composition, 4700 Ohm, 1/4W, 5% (R7, 9) .	2	
-12	041-651			. RESISTOR, Carbon Composition, 33 Ohm, 1/4W, 5% (Q8, 10) . .	2	
-13	041-504			. RESISTOR, Carbon Composition, 510 Ohm, 1/4W, 5% (R11, 12) .	2	
-14	041-550			. RESISTOR, Carbon Composition, 3000 Ohm, 1/4W, 5% (R13, 14, 26, 27, 39, 40)	6	
-15	041-013			. RESISTOR, Carbon Composition, 4700 Ohm, 1/2W, 5% (R17, 18, 30, 31, 43, 44)	6	
-16	041-317			. RESISTOR, Carbon Composition, 820 Ohm, 1/2W, 5% (R19, . . 32, 45)	3	
-17	041-007			. RESISTOR, Carbon Composition, 750 Ohm, 1/2W, 5% (R20, 33, 46)	3	
-18	013-983	∴		. DIODE (VR1)	1	
-19	280-100	∴		. PAD, Transistor Mounting	19	
-20	280-998	∴		. PAD, Transistor Mounting	2	
-21	1361557-01			. PRINTED WIRING BOARD.	1	

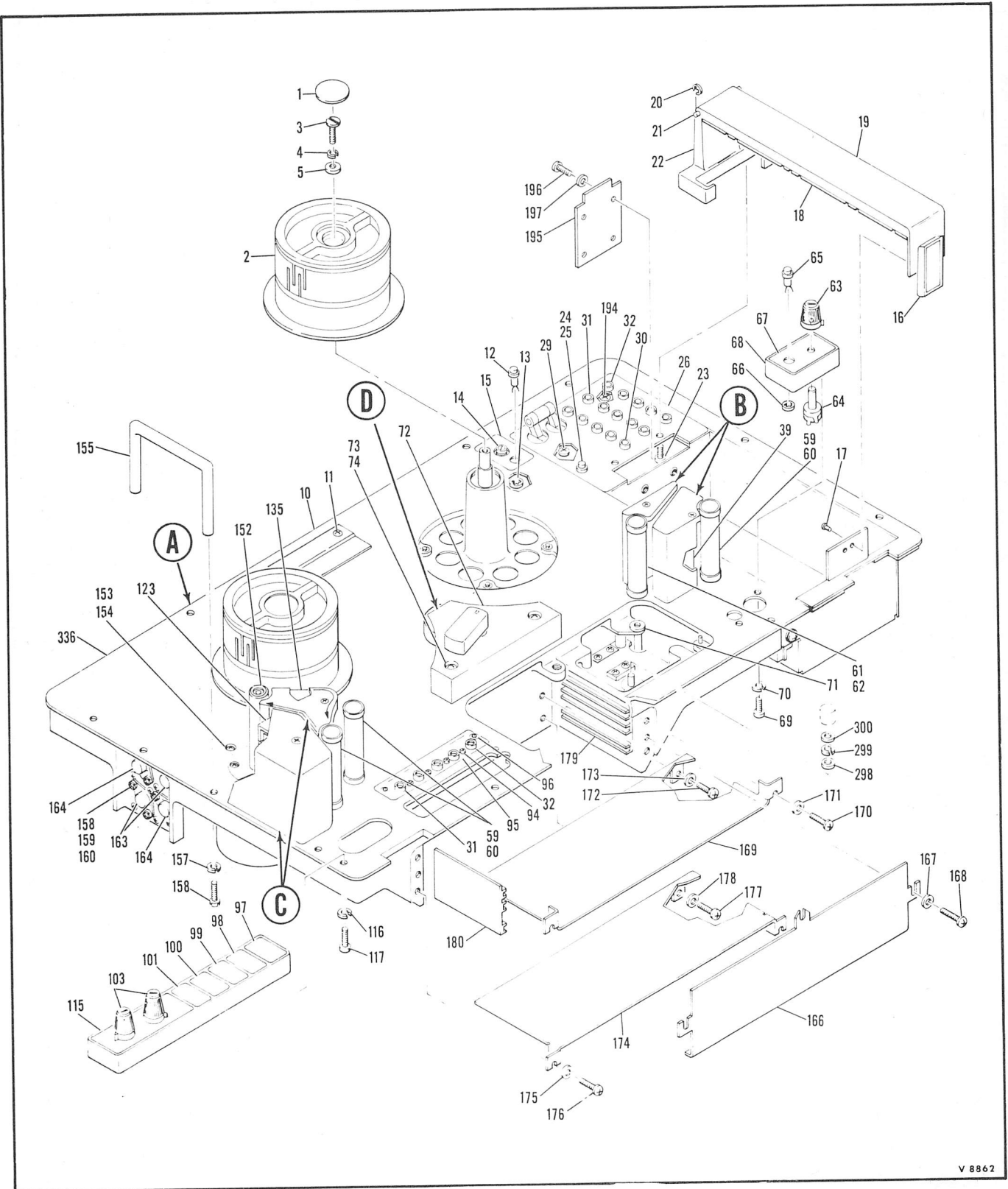


Figure 11-24. Tape Transport Assembly (Sheet 1 of 4)

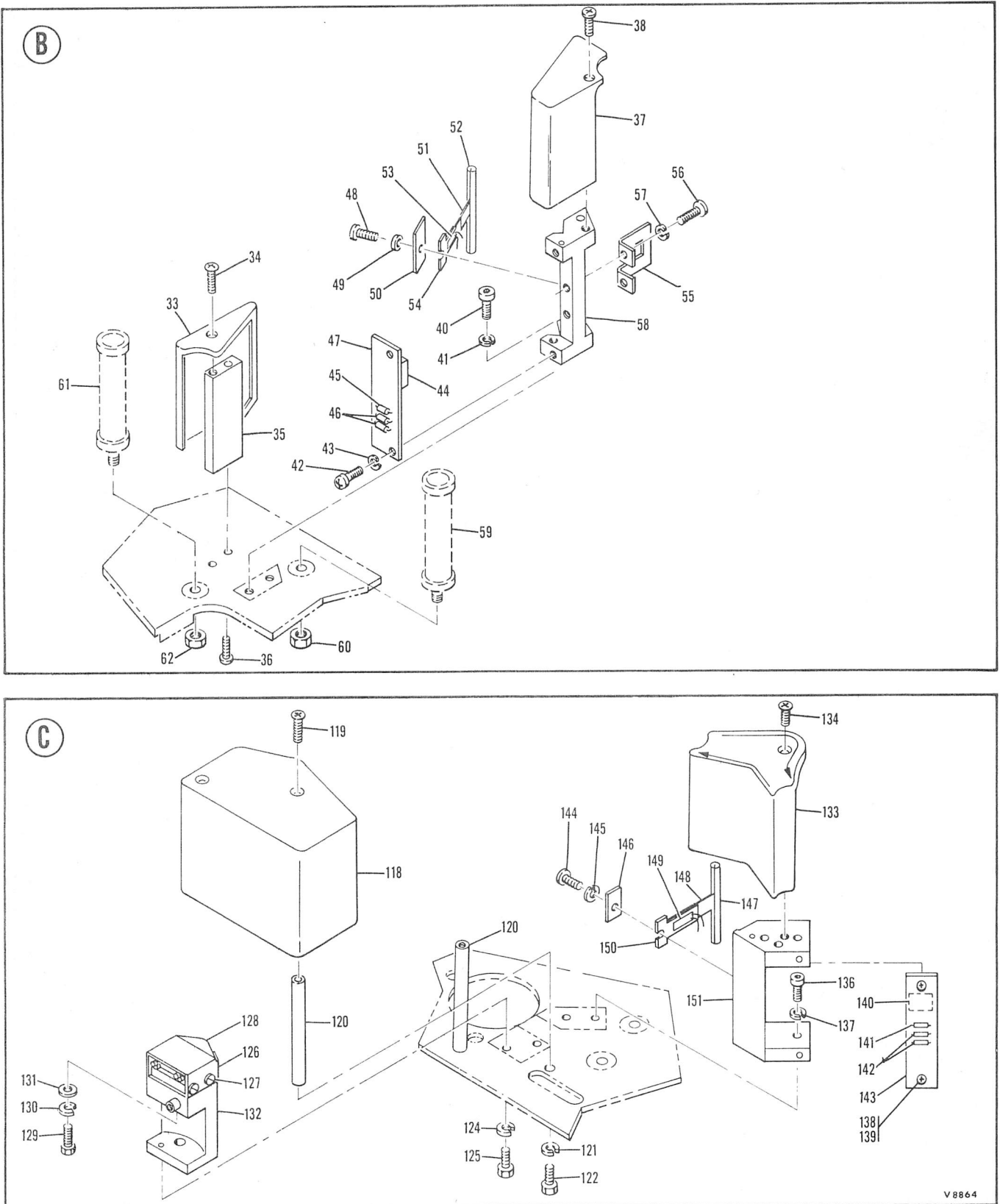
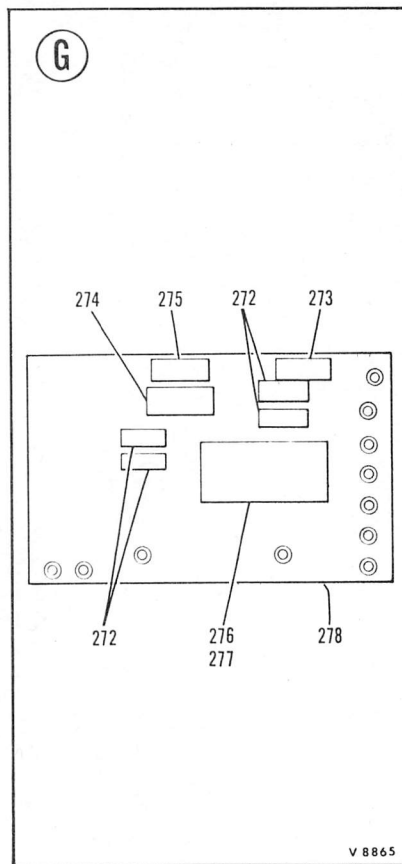
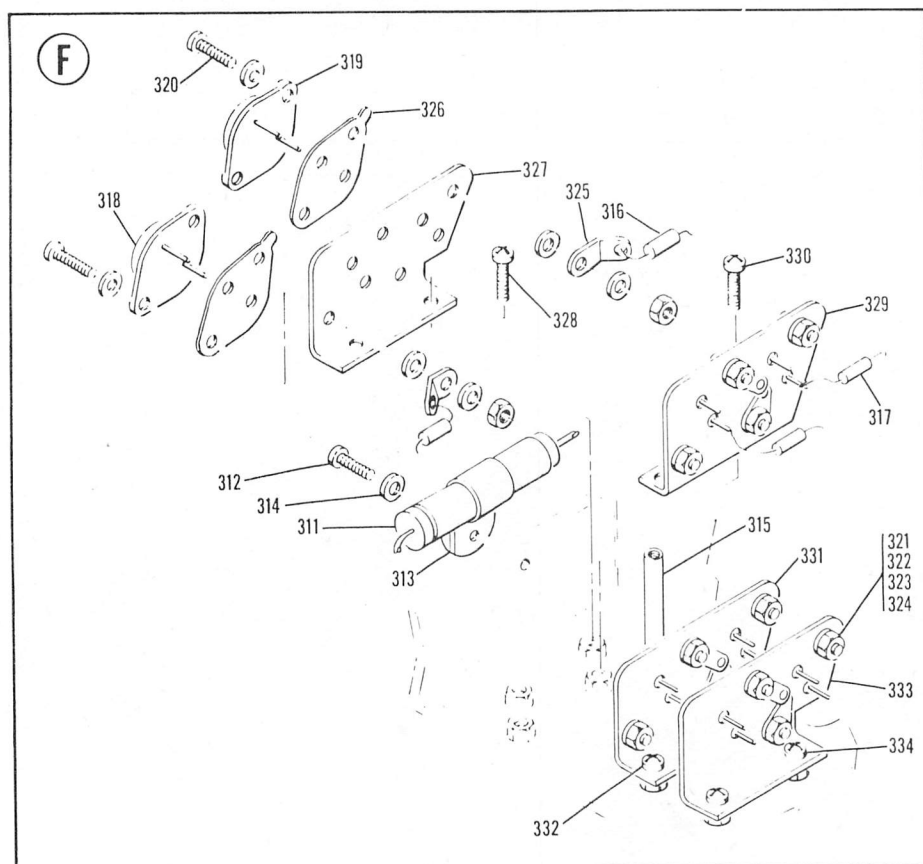
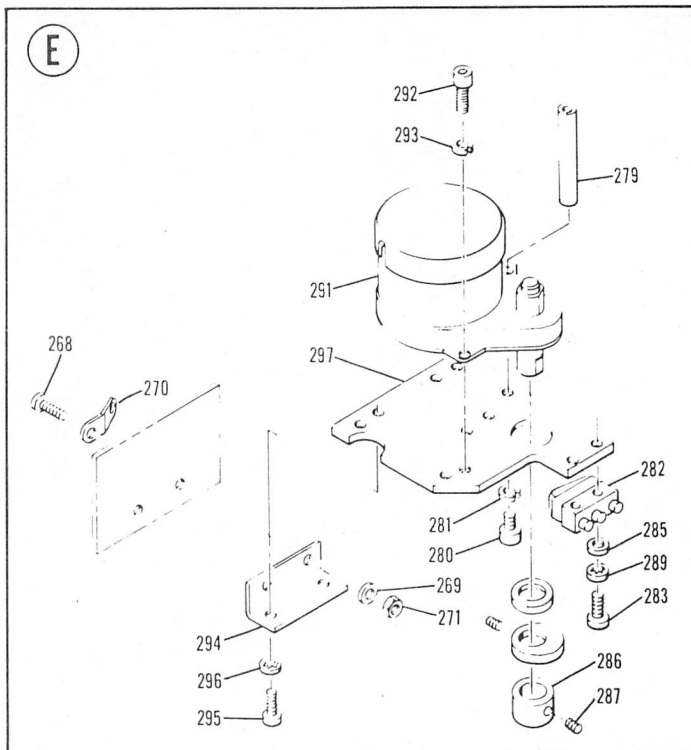
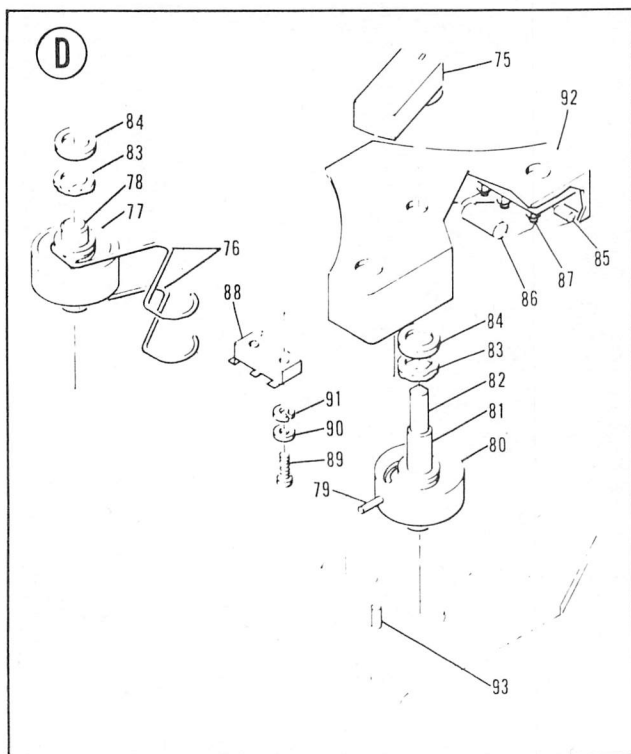


Figure 11-24. Tape Transport Assembly (Sheet 3 of 4)



V 8865

Figure 11-24. Tape Transport Assembly (Sheet 4 of 4)

TAPE TRANSPORT ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
24	1361550-02			TAPE TRANSPORT ASSEMBLY, (See Figure 2-29 For Next Higher Assembly)	Ref	
-1	1361510-02			. ESCUTCHEON.	2	
-2	1361508-01			. HOLDDOWN KNOB AND TURNTABLE ASSEMBLY (Factory . . Service Only)	2	
-3	471-496			. SCREW, Binder Head, Slotted, 6-32 x 1/2 Lg (AP)	2	
-4	502-003			. WASHER, Lock, Spring, #6 (AP)	2	
-5	501-009			. WASHER, Flat, #6 (AP)	2	
-6	1363806-01			. TAKEUP MOTOR ASSEMBLY (Factory Service Only) (A2) . . .	1	
-7	1363803-01			. SUPPLY MOTOR ASSEMBLY (Factory Service Only) (A1) . . .	1	
-8	470-010			. SCREW, Cap, Hex Socket Drive, 4-40 x 3/8 Lg(AP)	8	
-9	502-002			. WASHER, Lock, Spring, #4 (AP)	8	
-10	1361721-01			. COVER, Trademark	1	
-11	470-470			. SCREW, Button Head, Hex Socket Drive, 4-40 x 3/16 Lg (AP) .	2	
-12	132-148	∴		. LIGHT, Indicator, Orange (DS2).	1	
-13	502-027			. WASHER, Lock, Internal Tooth, #10.	1	
-14	058-351			. RESISTOR, Variable, Wirewound, 200 Ohm, 0.500W, 5% (R6) .	1	
-15	1361735-01			. OVERLAY, Video Level	1	
-16	310-515	∴		. FASTENER, Latch	1	
-17	460-124			. RIVET, 100° Countersink, Tubular, 0.094 Dia x 0.250 Lg (AP).	4	
-18	269-302	∴		. FOAM RUBBER, Closed Cell Neoprene, 3/8 Thick	AR	
-19	1361549-01			. CLAMP, Power Case	1	
-20	430-230			. RING, Retaining, External (AP).	2	
-21	1361634-01			. SHAFT, Clamp (AP)	1	
-22	1361539-01			. BRACKET, Guide-Support	1	
-23	475-064			. SCREW, Pan Head, Xrecess, 6-32 x 1/4 Lg (AP)	2	
-24	132-145	∴		. LIGHT, Indicator, Red (DS3)	1	
-25	502-027			. WASHER, Lock, Internal Tooth, #10.	1	
-26	1361644-01			. OVERLAY	1	
-27	1363378-01			. PRINTED WIRING BOARD, Circuit Breaker	1	
-28	126-178			. CIRCUIT BREAKER, 5 Amp, 2 Pole, 50VDC (CB1)	1	
-29	472-303			. SCREW, Flat Head, Xrecess, 100° Countersink, 6-32 x 1/4 Lg . (AP)	4	
-30	148-039	∴		. TEST POINT, Tip Jack, Connector, Black (TP18).	1	
-31	148-042	∴		. TEST POINT, Tip Jack, Connector, White (TP5, 7)	2	
-32	148-038	∴		. TEST POINT, Tip Jack, Connector, Red (TP1-4, 6, 8-17, 19, 20).	17	
-33	1361677-01			. COVER, Tape Guard.	1	
-34	470-460			. SCREW, Flat Head, Hex Socket Drive, 4-40 x 5/16 Lg (AP) . .	1	
-35	1363364-01			. POST, Tape Guard	1	
-36	470-460			. SCREW, Flat Head, Hex Socket Drive, 4-40 x 5/16 Lg (AP) . .	2	
-37	1361680-01			. COVER, Compliance Arm, Supply	1	
-38	470-460			. SCREW, Flat Head, Hex Socket Drive, 4-40 x 5/16 Lg (AP) . .	1	
-39	1361625-03			. TAPE COMPLIANCE ASSEMBLY, Supply	1	
-40	470-010			. SCREW, Cap, Hex Socket Drive, 4-40 x 3/8 Lg (AP)	2	
-41	502-002			. WASHER, Lock, Spring, #4.	2	
-42	1361731-01			. . PRINTED WIRING ASSEMBLY, Compliance Tension, Adjust. .	1	
-43	471-059			. . SCREW, Machine, Pan Head, Xrecess, 4-40 x 3/16 Lg (AP) .	2	
-44	502-002			. . WASHER, Lock, Spring, #4 (AP)	2	
-45	055-447			. . . RESISTOR, Variable, Wirewound, 500 Ohm, 1/4W, 5% (R1).	1	
-46	057-081			. . . RESISTOR, Mylar Foil, 240 Ohm, 1/4W, 2% (R2)	1	
-47	057-120			. . . RESISTOR, Mylar Foil, 10,000 Ohm, 1/4W, 2% (R3, 4). . .	2	
-47	1361732-01			. . . PRINTED WIRING BOARD.	1	

TAPE TRANSPORT ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
24-48	472-453			. . SCREW, Machine, Pan Head, Xrecess, 2-56 x 5/16 Lg . . .	1	
-49	502-001			. . WASHER, Lock, Spring, #2.	1	
-50	1361630-01			. . CLAMP, Compliance arm	1	
	1361631-03			. . COMPLIANCE ARM ASSEMBLY.	1	
-51	1361627-01			. . . ARM, Compliance	1	
-52	1361628-01			. . . ROD, Compliance Arm	1	
	1363653-02			. . STRAIN GAUGE ASSEMBLY	1	
-53	1380150-01			. . . STRAIN GAUGE, Semi-Conductor (Ampex Specification . . Drawing)	1	
-54	1363652-02			. . . ARM, Strain Gauge.	1	
-55	1361632-01			. . BRACKET, Stop, Compliance Arm, Supply.	1	
-56	471-062			. . SCREW, Machine, Pan Head, Xrecess, 4-40 x 3/8 Lg (AP) .	2	
-57	502-002			. . WASHER, Lock, Spring, #4	2	
-58	1361629-01			. . POST, Compliance Arm, Supply.	1	
-59	1361509-05			. IDLER ASSEMBLY (Factory Service Only)	3	
-60	496-007			. NUT, Keps, 10-32 (AP)	3	
-61	1361509-06			. IDLER ASSEMBLY (Factory Service Only)	1	
-62	496-007			. NUT, Keps, 10-32 (AP)	1	
-63	6000001-20			. KNOB	1	
-64	058-350			. RESISTOR, Variable, Carbon, 5000 Ohm, 0.200W, 20% (R5). .	1	
-65	132-144	..		. LIGHT, Indicator, Green (DS1)	1	
-66	205-027			. WASHER, Lock, Internal Tooth, #10	1	
-67	1361695-01			. OVERLAY, Right Transport Control	1	
-68	1361696-01			. BEZEL, Right Transport Control	1	
-69	470-010			. SCREW, Cap, Hex Socket Drive, 4-40 x 3/8 Lg (AP)	2	
-70	502-002			. WASHER, Lock, Spring, #4 (AP)	2	
-71	1363441-01			. GASKET, Air Hose	1	
-72	1363385-01			. PARKING BRAKE ASSEMBLY	1	
-73	470-481			. SCREW, Button Head, Hex Socket Drive, 8-32 x 7/8 Lg (AP). .	2	
-74	502-004			. WASHER, Lock, Spring, #8 (AP)	2	
-75	4100157-10			. KNOB	1	
-76	1363347-01			. SPRING, Parking Brake	2	
	1361653-01			. BRAKE ASSEMBLY, Parking Brake	1	
-77	1361651-01			. . RING, Brake	1	
-78	1361652-01			. . BRAKE, Bearing Core	1	
	1361655-01			. ECCENTRIC ASSEMBLY, Parking Brake.	1	
-79	406-024	..		. . PIN, Spring, 0.062 Dia. x 0.625 Lg	1	
-80	1361654-01			. . ECCENTRIC, Brake	1	
-81	1361652-01			. . BRAKE, Bearing Core	1	
-82	1361640-01			. . SHAFT, Drive, Parking Brake	1	
-83	352-006			. WASHER, Wavy Spring, 0.618 O.D. x 0.440 I.D. x 0.008 Thick .	2	
-84	501-660			. WASHER, Nylon, 0.629 O.D. x 0.437 I.D. x 0.032 Thick. . .	2	
-85	013-599			. DIODE (CR1)	1	
-86	041-334			. RESISTOR, Carbon Composition, 200 Ohm, 1/2W, 5% (R1). .	1	
-87	173-004			. TERMINAL, Stud, Turret, 2-56 UNC-2A (E1-3).	3	
-88	120-122	..		. SWITCH, Snap Action, SPDT, 5 Amp, 125-250 VAC (S1) . . .	1	
-89	472-456			. SCREW, Machine, Pan Head, Xrecess, 2-56 UNC-2A x 1/2 Lg (AP)	2	
-90	502-023			. WASHER, Lock, Internal Tooth #2 (AP)	2	
-91	501-155			. WASHER, Flat, #2 (AP)	2	
-92	1361641-01			. COVER, Parking Brake	1	
-93	406-022	..		. PIN, Spring, 0.062 Dia x 0.375 Lg	1	
-94	058-324			. RESISTOR, Variable, Wirewound, 10,000 Ohm, 1W, 5% (R1-4).	4	

TAPE TRANSPORT ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
24-95	1361714-01			. OVERLAY, Head Driver Voltage.	1	
-96	470-470			. SCREW, Button Head, Hex Socket Drive, 4-40 x 3/16 Lg (AP). .	2	
-97	1363823-05			. PUSHBUTTON, Control Panel	1	
-98	1363823-04			. PUSHBUTTON, Control Panel	1	
-99	1363823-03			. PUSHBUTTON, Control Panel	1	
-100	1363823-02			. PUSHBUTTON, Control Panel	1	
-101	1363823-01			. PUSHBUTTON, Control Panel	1	
-102	1363844-01			. SHAFT, Pushbutton (Attaching Parts For Index Numbers 97 Thru 101)	5	
-103	6000001-20			. KNOB	2	
-104	476-068			. SCREW, Self-Tap, Pan Head, Slotted, 2-56 x 3/16 Lg	10	
-105	120-869			. SWITCH, Micro, SPDT (S3-7)	5	
-106	472-455			. SCREW, Pan Head, Xrecess, 2-56 x 7/16 Lg (AP).	10	
-107	502-023			. WASHER, Lock, Internal Tooth, #2 (AP)	10	
-108	492-466			. NUT, Plain, Hexagon, #2-56 (AP)	10	
-109	1363822-01			. BRACKET, Switch	5	
-110	1363822-02			. BRACKET, Switch	5	
-111	122-257	..		. SWITCH, Rotary, DPDT, 1 Amp, 250 VDC, 0.008 Ohm Maximum (S2)	1	
-112	057-079			. RESISTOR, Metal Film, 200 Ohm, 0.250W, 2% (R14,15)	2	
-113	057-103			. RESISTOR, Metal Film, 2000 Ohm, 0.250W, 2% (R12,13,16,17)	4	
-114	122-322	..		. SWITCH, Rotary, 3P3 Pos, 0.250 Amp, 6-28VDC (S1)	1	
-115	1363821-01			. BEZEL, Left Transport Control	1	
-116	470-474			. SCREW, Cap, Hex Socket Drive, 4-40 x 5/16 Lg (AP)	2	
-117	502-002			. WASHER, Lock, Spring, #4 (AP)	2	
-118	1361698-01			. COVER, Audio Head Assembly	1	
-119	470-460			. SCREW, Flat Head, Hex Socket Drive, 4-40 x 5/16 Lg (AP) . .	2	
-120	1361678-01			. POST, Audio Head Cover	2	
-121	470-010			. SCREW, Cap, Hex Socket Drive, 4-40 x 3/8 Lg (AP).	2	
-122	502-002			. WASHER, Lock, Spring, #4 (AP)	2	
-123	1361618-01			. POST ASSEMBLY, Audio Head	1	
-124	470-012			. SCREW, Cap, Hex Socket Drive, 4-40 x 1/2 Lg (AP).	2	
-125	502-002			. WASHER, Lock, Spring, #4 (AP)	2	
-126	1232639-01			. SHIELD, Head	1	
-127	476-068			. SCREW, Self-Tapping, 2-56 x 0.187 Lg (AP)	4	
-128	1232645-01			. HEAD STACK ASSEMBLY, Record/Reproduce.	1	
-129	470-039			. SCREW, Cap, Hex Socket, 10-32 UNF-3A x 0.62 Lg (AP). . .	1	
-130	502-121			. WASHER, Lock, Split, #10 (AP)	1	
-131	501-057			. SHIM, Round, 0.20 I.D. (AP)	1	
-132	1361513-01			. POST ASSEMBLY, Head Mounting, Audio Head	1	
-133	1361681-01			. COVER, Tape Compliance, Takeup	1	
-134	470-460			. SCREW, Flat Head, Hex Socket Drive, 4-40 x 5/16 Lg (AP) . .	1	
-135	1361626-03			. TAPE COMPLIANCE ASSEMBLY, Takeup	1	
-136	470-010			. SCREW, Cap, Hex Socket Drive, 4-40 x 3/8 Lg (AP).	2	
-137	502-002			. WASHER, Lock, Spring, #4 (AP)	2	
	1361731-01			. PRINTED WIRING ASSEMBLY, Compliance Tension, Adjust .	1	
-138	471-060			. SCREW, Machine, Pan Head, 4-40 x 1/4 Lg (AP).	2	
-139	502-002			. WASHER, Lock, Spring, #4 (AP).	2	
-140	055-447			. RESISTOR, Variable, Wirewound, 500 Ohm, 1/4W, 5% (R1). .	1	
-141	057-081			. RESISTOR, Mylar Foil, 240 Ohm, 1/4W, 2% (R2)	1	
-142	057-120			. RESISTOR, Mylar Foil, 10,000 Ohm, 1/4W, 2% (R3,4) . . .	2	
-143	1361732-01			. PRINTED WIRING BOARD.	1	

TAPE TRANSPORT ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
24-144	472-113			. . SCREW, Machine, Xrecess, Pan Head, 2-56 x 1/4 Lg.	1	
-145	502-001			. . WASHER, Lock, Spring, #2.	1	
-146	1361630-01			. . CLAMP, Compliance Arm	1	
	1361631-04			. . COMPLIANCE ARM ASSEMBLY.	1	
-147	1361628-01			. . . ROD, Compliance Arm	1	
-148	1361627-02			. . . ARM, Compliance	1	
	1363653-02			. . STRAIN GAGE ASSEMBLY	1	
-149	1380150-01			. . . STRAIN GAGE (Ampex Specification Drawing)	1	
-150	1363652-02			. . . ARM, Strain Gage	1	
-151	1361633-01			. . POST, Compliance Arm, Takeup	1	
-152	1361520-01			. CAPSTAN ASSEMBLY (Factory Service Only)	1	
-153	470-010			. SCREW, Cap, Hex Socket Drive, 4-40 x 3/8 Lg (AP)	3	
-154	502-002			. WASHER, Lock, Spring, #4 (AP)	3	
-155	089-056	∞		. HANDLE	1	
-156	470-029			. SCREW, Cap, Hex Socket Drive, 8-32 x 1/2 Lg (AP)	2	
-157	502-004			. WASHER, Lock, Spring, #8 (AP)	2	
-158	471-063			. SCREW, Pan Head, Xrecess, 4-40 x 7/16 Lg.	8	
-159	501-008			. WASHER, Flat, #4	8	
	172-004			. TERMINAL LUG, #4, Locking (AP)	4	
-160	496-004			. NUT, Keps, 4-40	8	
-161	043-581			. RESISTOR, Wirewound, Power, 0.3 Ohm, 3W, 3% (R11,19) . .	2	
-162	055-158			. CAPACITOR, Mylar Foil, 0.068 UF, 50V, 5% (C1,2)	2	
-163	014-720			. TRANSISTOR (2N3740) (Q2,4)	2	
-164	014-947			. TRANSISTOR (2N3766) (Q1,3)	2	
-165	014-833	∞		. MOUNTING KIT, Transistor	4	
-166	1363396-02			. SHIELD, Signal Area	1	
-167	475-055			. SCREW, Pan Head, Xrecess, 4-40 x 5/16 Lg, Sem (AP)	3	
-168	501-008			. WASHER, Flat, #4 (AP)	3	
-169	1363322-03			. SHIELD, Signal, Printed Wiring Board	1	
-170	475-055			. SCREW, Pan Head, Xrecess, 4-40 x 5/16 Lg, Sem (AP)	2	
-171	501-008			. WASHER, Flat, #4 (AP).	2	
-172	472-113			. SCREW, Pan Head, Xrecess, 2-56 x 1/4 Lg (AP)	3	
-173	502-023			. WASHER, Lock, Internal Tooth, #2 (AP).	3	
-174	1363322-04			. SHIELD, Signal, Printed Wiring Board	1	
-175	475-055			. SCREW, Pan Head, Xrecess, 4-40 x 5/16 Lg, Sem (AP). . . .	2	
-176	501-008			. WASHER, Flat, #4 (AP)	2	
-177	472-113			. SCREW, Pan Head, Xrecess, 2-56 x 1/4 Lg (AP)	3	
-178	502-023			. WASHER, Lock, Internal Tooth, #2 (AP).	3	
-179	1380168-01			. SLIDE, Signal Printed Wiring Assembly (Ampex Specification . Drawing)	1	
-180	1380168-02			. SLIDE, Signal Printed Wiring Assembly (Ampex Specification . Drawing)	1	
-181	148-003	∞		. CONNECTOR, Receptacle, Electrical (J4)	1	
-182	142-026	∞		. CONNECTOR, Receptacle, Electrical (J3,7,8)	3	
-183	143-794	∞		. CONNECTOR, Receptacle, Electrical (J1)	1	
-184	471-062			. SCREW, Pan Head, Xrecess, 4-40 x 3/8 Lg (AP)	4	
-185	172-038			. TERMINAL LUG, #4, Plain (AP)	1	
-186	496-004			. NUT, Keps, 4-40 (AP)	4	
-187	146-998	∞		. CONNECTOR, Receptacle, Electrical (J1)	1	
-188	471-327			. SCREW, Flat Head, Xrecess, 4-40 x 5/16 Lg (AP)	2	
-189	496-004			. NUT, Keps, 4-40 (AP)	2	
-190	302-074	∞		. CLAMP, Cable, 1/4 I.D.	1	

TAPE TRANSPORT ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
24-191	475-058			. SCREW, Pan Head, Xrecess, 6-32 x 3/8 Lg, Sem (AP)	1	
-192	506-013	..		. WASHER, "D", Cable Clamp (AP).	1	
-193	1363716-01			. PLATE, Test Point, Power Chassis.	1	
-194	471-326			. SCREW, Flat Head, Xrecess, 4-40 x 1/4 Lg (AP).	4	
-195	1361748-01			. PRINTED WIRING BOARD, Power Chassis.	1	
-196	475-046			. SCREW, Pan Head, Xrecess, 4-40 x 3/8 Lg, Sem (AP)	4	
-197	501-008			. WASHER, Flat, #4 (AP)	4	
-198	1211910-01			. TERMINAL, Quad, Signal and Servo Systems.	1	
-199	475-057			. SCREW, Pan Head, Xrecess, 10-32 x 3/8 Lg, Sem (AP).	1	
-200	1361621-01			. CHASSIS, Power	1	
-201	475-058			. SCREW, Pan Head, Xrecess, 6-32 x 3/8 Lg, Sem (AP)	4	
-202	501-009			. WASHER, Flat, #6 (AP)	4	
-203	1361736-01			. HOLDDOWN, Input-Output, Standards, Printed.	1	
				Wiring Assemblies		
-204	475-055			. SCREW, Pan Head, Xrecess, 4-40 x 5/16 Lg, Sem (AP).	2	
-205	501-008			. WASHER, Flat, #4 (AP)	2	
-206	143-801	..		. CONNECTOR, Receptacle, Electrical (J18,19)	2	
-207	475-103			. SCREW, Pan Head, Xrecess, 4-40 x 1/2 Lg, Sem (AP)	4	
-208	501-169			. WASHER, Flat, #4 (AP)	4	
-209	1361700-01			. BRACKET, Ground	2	
-210	1360186-01			. SLIDE, Input-Output and Standards Printed Wiring Assemblies	2	
				(Ampex Specification Drawing)		
-211	1361724-01			. HOLDDOWN, Servo, Printed Wiring Assemblies	1	
-212	475-001			. SCREW, Pan Head, Xrecess, 4-40 x 1/4 Lg, Sem (AP)	2	
-213	143-801	..		. CONNECTOR, Receptacle, Electrical (J26,27)	2	
-214	471-063			. SCREW, Pan Head, Xrecess, 4-40 x 7/16 Lg (AP)	4	
-215	502-024			. WASHER, Lock, Internal Tooth, #4 (AP).	4	
-216	501-169			. WASHER, Flat, #4 (AP)	4	
-217	143-198	..		. CONNECTOR, Receptacle, Electrical (J11,17)	2	
-218	475-053			. SCREW, Pan Head, Xrecess, 4-40 x 5/8 Lg, Sem (AP)	4	
-219	501-008			. WASHER, Flat, #4 (AP)	4	
-220	1361702-01			. BRACKET, Ground, Servo Printed Wiring Assemblies	5	
-221	143-198	..		. CONNECTOR, Receptacle, Electrical (J12-15)	4	
-222	475-103			. SCREW, Pan Head, Xrecess, 4-40 x 1/2 Lg, Sem (AP)	8	
-223	501-008			. WASHER, Flat, #4 (AP)	8	
-224	1361619-01			. CONNECTOR, Mount Servo Board.	2	
-225	1380165-01			. SLIDE, Servo Printed Wiring Assemblies (Ampex Specification	1	
				Drawing)		
-226	1380165-02			. SLIDE, Servo Printed Wiring Assemblies (Ampex Specification	1	
				Drawing)		
-227	1361704-01			. 3.6V POWER SUPPLY ASSEMBLY (Factory Service Only)	1	
-228	475-001			. SCREW, Pan Head, Xrecess, 4-40 x 1/4 Lg, Sem (AP)	1	
-229	471-327			. SCREW, Flat Head, Xrecess, 4-40 x 5/16 (AP).	2	
-230	496-004			. NUT, Keps, 4-40 (AP)	2	
-231	1361687-01			. VACUUM PUMP ASSEMBLY (Factory Service Only).	1	
-232	475-001			. SCREW, Pan Head, Xrecess, 4-40 x 1/4 Lg, Sem (AP)	2	
-233	471-327			. SCREW, Flat Head, Xrecess, 4-40 x 5/16 Lg (AP)	1	
-234	496-004			. NUT, Keps, 4-40 (AP)	1	
-235	1361610-01			. VACUUM REGULATOR ASSEMBLY (Factory Service Only)	1	
-236	471-327			. SCREW, Flat Head, Xrecess, 4-40 x 5/16 Lg (AP)	2	
-237	143-801	..		. CONNECTOR, Receptacle, Electrical (J20,24)	2	
-238	475-103			. SCREW, Pan Head, Xrecess, 4-40 x 1/2 Lg, Sem (AP)	4	

TAPE TRANSPORT ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
24-239	501-049			. WASHER, Flat, #4 (AP)	4	
-240	1361700-01			. BRACKET, Ground	2	
-241	1361697-01			. SHIELD, Power Distribution Printed Wiring Assembly	1	
	280-046			. SPACER, Threaded, Swage, 2-56	1	
-242	146-448	..		. CONNECTOR, Receptacle, Electrical (J21, 23)	3	
-243	471-328			. SCREW, Flat Head, Xrecess, 4-40 x 3/8 Lg (AP)	6	
-244	1361701-01			. BRACKET, Ground, Signal Printed Wiring Assemblies	3	
-245	1361713-01			. STIFFENER, Rib, Top Plate	1	
-246	470-009			. SCREW, Cap, Hex Socket Drive, 4-40 x 5/16 Lg (AP)	4	
-247	502-002			. WASHER, Lock, Spring, #4 (AP)	4	
-248	037-455			. CAPACITOR, Tantalum, 1UF, 35V, 5% (C3)	1	
-249	041-496			. RESISTOR, Carbon Composition, 10 Ohm, 1/4W, 5% (R18)	1	
-250	146-402	..		. CONNECTOR, Receptacle, Electrical (J25)	1	
-251	471-063			. SCREW, Pan Head, Xrecess, 4-40 x 7/16 Lg (AP)	2	
-252	502-024			. WASHER, Lock, Internal Tooth, #4 (AP)	2	
-253	501-008			. WASHER, Flat, #4 (AP)	2	
-254	173-004			. TERMINAL STUD, Turret, 2-56 (E1)	1	
-255	502-023			. WASHER, Lock, Internal Tooth, #2	1	
-256	501-635			. WASHER, Flat, #2	1	
-257	143-696	..		. CONNECTOR, Receptacle, Electrical (J6)	1	
-258	471-061			. SCREW, Pan Head, Xrecess, 4-40 x 5/16 Lg (AP)	2	
-259	172-004			. TERMINAL LUG, Locking #4 (AP)	1	
-260	492-008			. NUT, Plain, Hex, 4-40 (AP)	1	
-261	496-004			. NUT, Keps, 4-40 (AP)	1	
-262	302-080	..		. CLAMP, Cable, 3/16	1	
-263	475-058			. SCREW, Pan Head, Xrecess, 6-32 x 3/8 Lg, Sem (AP)	1	
-264	506-013	..		. WASHER, "D", Cable Clamp (AP)	1	
-265	280-373			. SPACER, Unthreaded, Swage, #2	1	
-266	1361661-01			. GUIDE ACTUATING ASSEMBLY	1	
-267	475-058			. SCREW, Pan Head, Xrecess, 6-32 x 3/8 Lg, Sem (AP)	3	
	1362929-01			. . PRINTED WIRING ASSEMBLY, Guide Retraction Control	1	
				Circuit		
-268	471-060			. . SCREW, Machine, Pan Head, Xrecess, 4-40 x 0.250 Lg (AP)	2	
-269	501-169			. . WASHER, Flat, #4 (AP)	2	
-270	172-004			. . TERMINAL LUG (AP)	1	
-271	496-004			. . NUT, Assembled Washer, 4-40 (AP)	2	
-272	013-599			. . DIODE (CR1, 2, 4, 5)	4	
-273	013-678			. . DIODE (CR3)	1	
-274	037-094			. . CAPACITOR, Tantalum, 10UF, 50V, ±20% (C1)	1	
-275	041-020			. . RESISTOR, 47000 Ohm, 1/2W, 5% (R1)	1	
-276	020-563			. . RELAY (K1)	1	
-277	020-407	..		. . SPACER, Relay	1	
-278	1362928-01			. . PRINTED WIRING BOARD	1	
-279	1363474-01			. . STANDOFF, Cable Clamp	1	
-280	470-017			. . SCREW, Cap, Hex Socket, 6-32 x 5/16 Lg (AP)	1	
-281	502-003			. . WASHER, Lock, Spring, #6 (AP)	1	
-282	120-122	..		. . SWITCH (S1, 2)	2	
-283	472-454			. . SCREW, Machine, Pan Head, Xrecess, 2-56 x 0.375 Lg (AP)	4	
-284	502-023			. . WASHER, Lock, Internal Tooth, #2 (AP)	4	
-285	501-233			. . WASHER, Flat, #2 (AP)	4	
-286	1361613-01			. . CAM, Actuating	1	

TAPE TRANSPORT ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
24-287	477-372			. . SCREW, Set, 4-40 x 1/8 Lg (AP)	1	
-288	1361612-01			. . CAM, Eccentric	1	
-289	477-372			. . SCREW, Set, 4-40 x 1/8 Lg (AP)	1	
-290	1361614-01			. . WASHER, Thrust, Actuating.	1	
-291	1380144-01			. . MOTDR, Guide Actuating (Ampex Specification Drawing)	1	
-292	470-015			. . SCREW, Cap, Hex Socket, 6-32 x 3/16 Lg (AP)	1	
-293	502-003			. . WASHER, Lock, Spring, #6 (AP)	1	
-294	1363398-01			. . BRACKET, Head Guide Actuator	1	
-295	475-001			. . SCREW, Machine, Pan Head, Xrecess, 4-40 x 0.250 Lg, ... Sem (AP)	2	
-296	502-024			. . WASHER, Lock, Internal Tooth, #4 (AP)	2	
-297	1361615-01			. . PLATE, Mount, Actuating Motor	1	
-298	501-049			. SHIM, Round, 0.250 I.D. x 0.438 O.D. x 0.002 Thick	AR	
-299	501-055			. SHIM, Round, 0.250 I.D. x 0.438 O.D. x 0.005 Thick	AR	
-300	501-058			. SHIM, Round, 0.250 I.D. x 0.375 O.D. x 0.010 Thick	AR	
-301	1380204-01			. FILTER, MDA (Ampex Specification Drawing)	1	
-302	496-004			. NUT, Keps, 4-40 (AP)	2	
-303	501-008			. WASHER, Flat, #4 (AP)	4	
-304	143-198	~		. CONNECTOR, Receptacle, Electrical (J20)	1	
-305	471-064			. SCREW, Pan Head, Xrecess, 4-40 x 1/2 Lg (AP)	2	
-306	502-002			. WASHER, Lock, Spring, #2 (AP)	2	
-307	501-008			. WASHER, Flat, #4 (AP)	2	
-308	1361686-01			. BRACKET, Connector, MDA Board	1	
-309	1361686-02			. BRACKET, Connector, MDA Board	1	
-310	471-327			. SCREW, Flat Head, Xrecess, 4-40 x 5/16 LG (AP)	4	
-311	037-223			. CAPACITOR, Tantalum, 100UF, 50V, -15 +75% (C4)	1	
-312	475-046			. SCREW, Pan Head, Xrecess, 4-40 x 3/8 Lg, Sem (AP)	1	
-313	302-076	~		. CLAMP, Cable, 3/8 I.D. (AP)	1	
-314	506-021	~		. WASHER, "D", Cable Clamp (AP)	1	
-315	1361720-01			. STANDOFF, MDA Printed Wiring Assembly	1	
-316	030-576			. CAPACITOR, Ceramic, 0.1UF, 50V, 10% (C5, 6)	2	
-317	013-678			. DIODE (CR1-6)	6	
-318	014-627			. TRANSISTOR (Q5, 7, 9, 12)	4	
-319	014-614			. TRANSISTOR (Q6, 8, 10, 11)	4	
-320	475-103			. SCREW, Pan Head, Xrecess, 4-40 x 1/2 Lg, Sem (AP)	8	
-321	471-063			. SCREW, Pan Head, Xrecess, 4-40 x 7/16 Lg (AP)	8	
-322	501-008			. WASHER, Flat, #4 (AP)	24	
-323	503-016			. WASHER, Fiber, Shoulder, #4 (AP)	16	
-324	496-004			. NUT, Keps, 4-40 (AP)	16	
-325	172-004			. TERMINAL LUG	8	
-326	280-994	~		. PAD, Mounting, Insulated.	8	
-327	1361684-01			. BRACKET, Right, MDA Transistor	1	
-328	475-001			. SCREW, Pan Head, Xrecess, 4-40 x 1/4 Lg, Sem (AP)	2	
-329	1361685-01			. BRACKET, Left, MDA Transistor	1	
-330	475-001			. SCREW, Pan Head, Xrecess, 4-40 x 1/4 Lg, Sem (AP)	2	
-331	1361684-02			. BRACKET, Right, MDA Transistor	1	
-332	475-001			. SCREW, Pan Head, Xrecess, 4-40 x 1/4 Lg, Sem (AP)	2	
-333	1361684-03			. BRACKET, Right, MDA Transistor	1	
-334	475-001			. SCREW, Pan Head, Xrecess, 4-40 x 1/4 Lg, Sem (AP)	2	
-335	1363820-01			. WIRING HARNESS	1	
-336	1361611-02			. TOP PLATE	1	

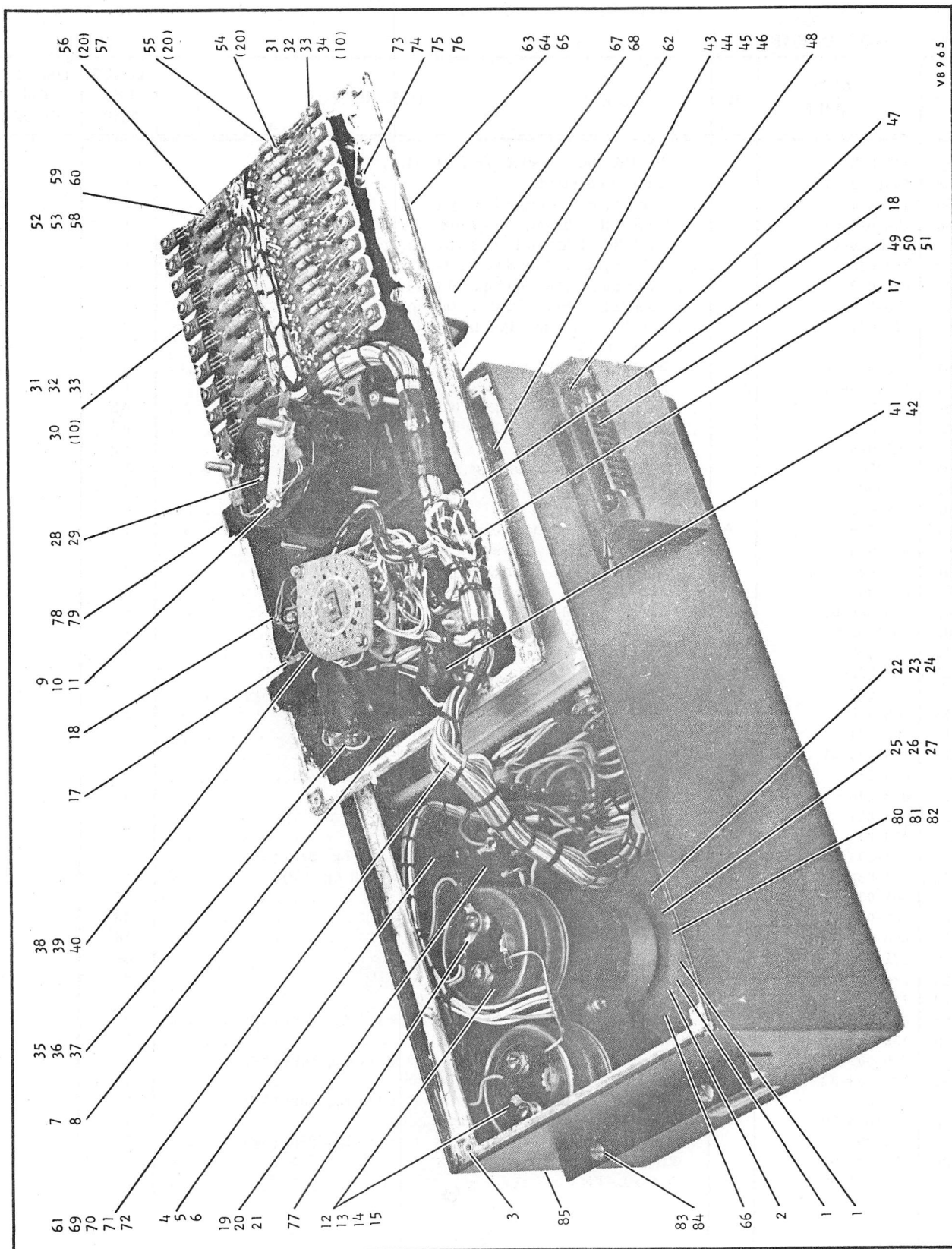


Figure 11-25. Battery Charger

FIG. & INDEX NO.	PART NUMBER	★	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
25	1805275-02			BATTERY CHARGER	Ref	
-1	1363426-01			. PRINTED WIRING ASSEMBLY, Board 1 & 2	2	
-2	1363430-01			. PRINTED WIRING ASSEMBLY, Board 3	1	
-3	1363588-03			. ELECTRONIC ASSEMBLY	1	
-4	013-855	∴		. . DIODE ASSEMBLY, Silicon, Quad (A1).	1	
-5	471-471			. . SCREW, Machine, Pan Head, Xrecess, 4-40 x 3/4 Lg.	2	
-6	018-027			. . ADHESIVE, Thread Locking	AR	
-7	126-162	∴		. . CIRCUIT BREAKER (CB1)	1	
-8	600-098			. . SLEEVING, Plastic, Shrink	AR	
-9	013-678	∴		. . DIODE, Silicon, CD451 (CR1,2)	2	
-10	492-010			. . NUT, Plain, Hex, #8.	2	
-11	171-006			. . TERMINAL, Lug	2	
-12	031-933			. . CAPACITOR, Aluminum, 21,000μF, 15V, -10+75% (C1,2)	2	
-13	1361703-01			. . CLAMP, Capacitor.	1	
-14	471-449			. . SCREW, Machine, Pan Head, Xrecess, 6-32 x 1-3/8 Lg.	1	
-15	502-025			. . WASHER, Lock, Internal, #6	1	
-16	501-009			. . WASHER, Flat, #6.	1	
-17	132-146	∴		. . LIGHT, Indicator, Red (DS1,3)	2	
-18	132-147	∴		. . LIGHT, Indicator, Green (DS2,4)	2	
-19	143-783	∴		. . CONNECTOR, Round, Receptacle, 9 Pins (J1)	1	
-20	496-004			. . NUT, Keps, 4-40	4	
-21	471-061			. . SCREW, Machine, Pan Head, Xrecess, 4-40 x 5/16 Lg.	4	
-22	143-198	∴		. . CONNECTOR, PC Receptacle, 22 Dual Contacts (J2,3).	2	
-23	169-318			. . KEY, Connector (J2,3)	2	
-24	475-027			. . SCREW, Machine, Assembled Washer, 4-40 x 3/8 Lg.	4	
-25	146-402	∴		. . CONNECTOR, PC Receptacle, 6 Dual Contacts (J4)	1	
-26	475-027			. . SCREW, Machine, Assembled Washer, 4-40 x 3/8 Lg.	2	
-27	501-169			. . WASHER, Flat, #4	2	
-28	1380177-01			. . METER, Specification Drawing (M1)	1	
-29	090-133	∴		. . BEZEL, Meter	1	
-30	014-960			. . TRANSISTOR, 2N4918 (Q1-10)	10	
-31	471-061			. . SCREW, Machine, Pan Head, Xrecess.	10	
-32	501-169			. . WASHER, Flat, #4	10	
-33	087-388			. . SILICON COMPOUND	AR	
-34	014-961			. . TRANSISTOR, 2N4921 (Q11-20)	10	
-35	120-828	∴		. . SWITCH, PB, 2PDT (S1)	1	
-36	498-286			. . NUT, Plain, Knurl, 1/4-40	1	
-37	502-028			. . WASHER, Lock, Internal, 1/4	1	
-38	1380176-01			. . SWITCH, Rotary (S2).	1	
-39	6000007-20			. . KNOB	1	
-40	501-071			. . WASHER, Flat, .390ID x .645 OD x .032	1	
-41	120-223	∴		. . SWITCH, Toggle, SPDT (S3)	1	
-42	600-095			. . SLEEVING, Plastic, Shrink, .500 ID	AR	
-43	1380181-02			. . TRANSFORMER (T1).	1	
-44	496-007			. . NUT, Keps, 10-32	4	
-45	260-052			. . GROMMET, Nylon, Cater	AR	
-46	018-010			. . ADHESIVE	AR	
-47	1361670-01			. . COVER, Printed Wiring Board	2	
-48	1361669-01			. . GUIDE, Connector	2	
-49	1361671-01			. . PRINTED WIRING CONNECTOR	2	
-50	471-327			. . SCREW, Machine, Flat Head, Xrecess, 4-40 x 5/16 Lg.	4	
-51	496-004			. . NUT, Keps, 4-40	4	
-52	1363432-01			. . PRINTED WIRING ASSEMBLY NO. 4	1	
-53	1363433-01			. . PRINTED WIRING BOARD	1	
-54	013-829	∴		. . DIODE, Zener, CD32, (VR1-20)	20	
-55	013-678			. . DIODE, Silicon, CD451 (CR1-20)	20	
-56	059-246			. . RESISTOR, Wirewound, 11 Ohm, 2W, 5%, (R1-20)	20	
-57	103307-02			. . STANDOFF	40	
-58	471-069			. . SCREW, Machine, Pan Head, Xrecess, 6-32 x 3/8 Lg.	2	
-59	501-009			. . WASHER, Flat, #6.	2	
-60	502-025			. . WASHER, Lock, Internal, #6.	2	
-61	1363382-02			. . HARNESS	1	

BATTERY CHARGER

FIG. & INDEX NO.	PART NUMBER	★	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
25-62	1361668-01			. . OVERLAY	1	
-63	1361663-01			. . COVER	1	
-64	470-471			. . SCREW, Cap, Hex Socket, 4-40 x 5/16 Lg	6	
-65	018-027			. . ADHESIVE, Thread Locking	AR	
-66	1363665-01			. . INSULATOR, Chassis	1	
-67	089-054	∴		. . HANDLE	1	
-68	475-084			. . SCREW, Machine, Assembled Washer, Slot, Hex, ... 8-32 x 1/2 Lg	2	
-69	302-006	∴		. . CLAMP, Cable	1	
-70	471-339			. . SCREW, Machine, Flat Head, Xrecess, 6-32 x 5/8 Lg.	1	
-71	496-005			. . NUT Keps, 6-32	1	
-72	506-013			. . WASHER, D.	1	
-73	310-042	∴		. . RECEPTACLE, Turnlock Fastener	2	
-74	472-469			. . SCREW, Machine, Flat Head, Xrecess, 2-56 x 3/8 Lg	4	
-75	492-007			. . NUT, Plain, Hex, #2	4	
-76	018-027			. . ADHESIVE	AR	
-77	171-007			TERMINAL, Lug	6	
-78	269-028			RUBBER, Sponge	AR	
-79	471-143			SCREW, Set, 6-32 x 3/4 Lg	2	
-80	530-154			GUIDE, Printed Wiring Board	6	
-81	472-289			SCREW, Machine, Flat Head, 4-40 x 3/16 Lg	6	
-82	018-027			ADHESIVE	AR	
-83	310-512	∴		STUD, Turnlock Fastener	4	
-84	310-245	∴		WASHER, Retaining, Turnlock Fastener	4	
-85	1361662-02			CHASSIS	1	

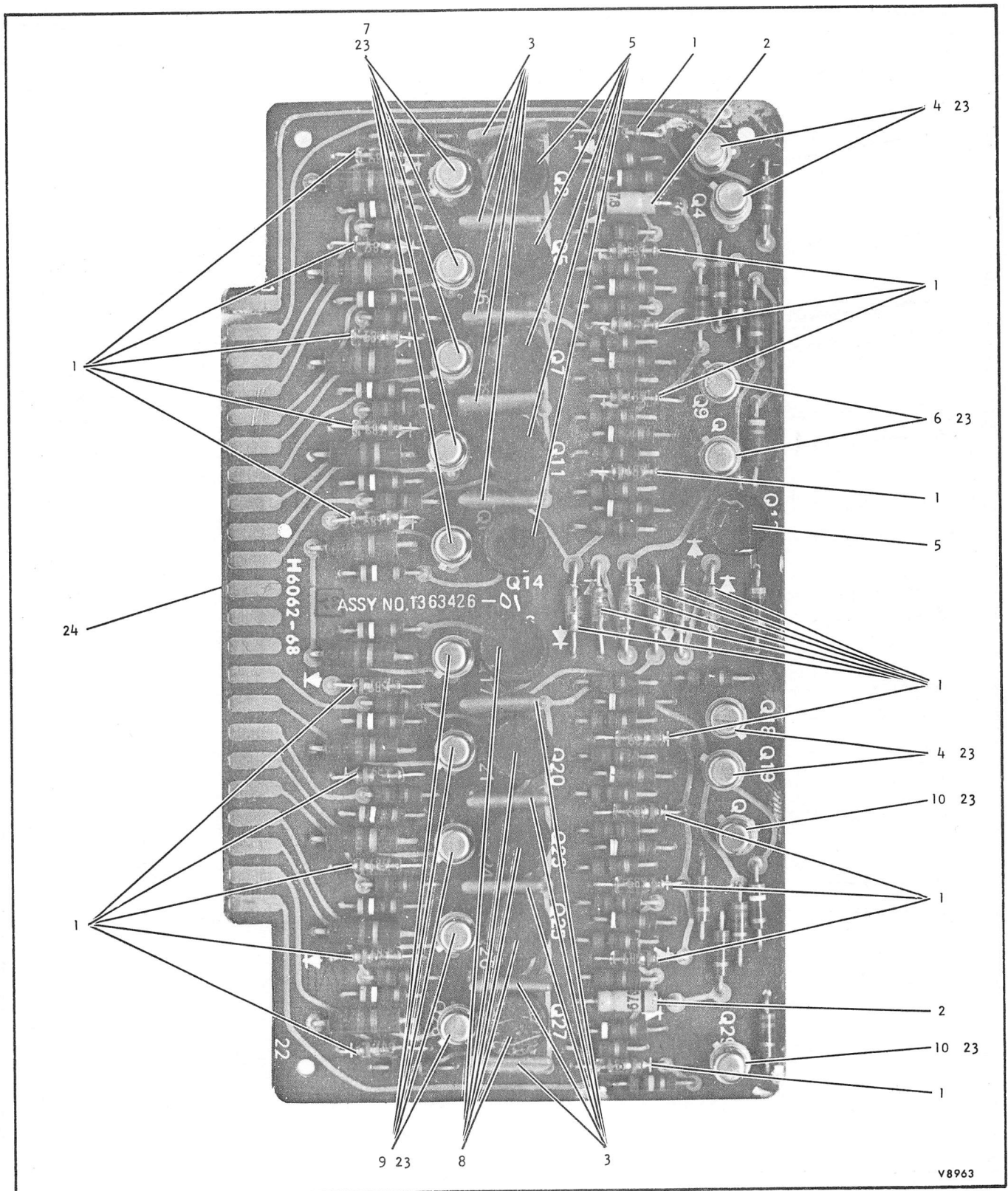


Figure 11-26. PWA Battery Charger (Board 1 and 2) (Sheet 1 of 2)

11-122

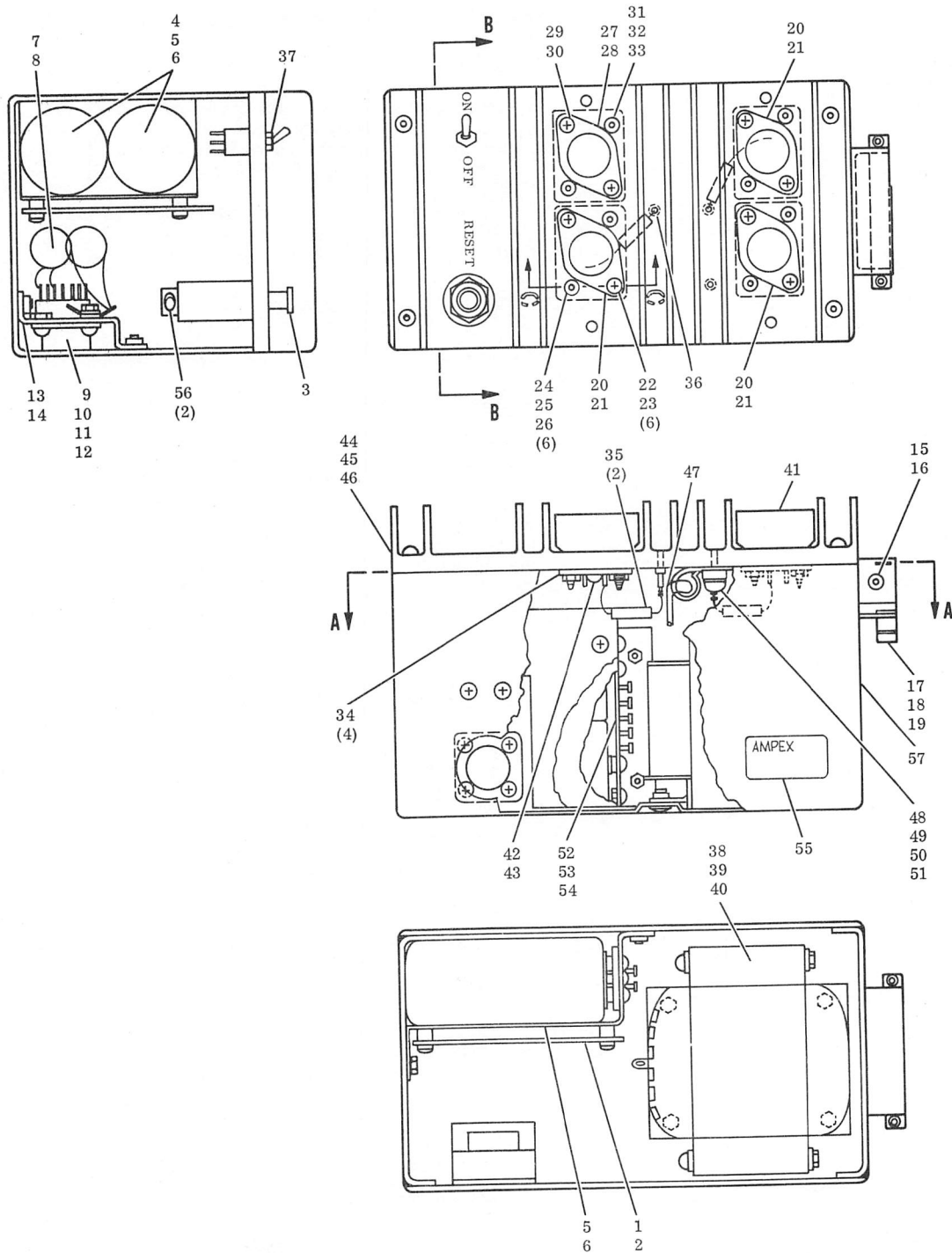
PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
26	1363426-01			PRINTED WIRING ASSEMBLY BATTERY CHARGER	Ref	
				BOARD 1 & 2 (See Figure 25 For Next Higher Assembly		
-1	013-689			. DIODE, CD6016 (CR1, 2, 4-25, 27, 28)	26	
-2	013-678	∴		. DIODE, CD451 (CR3, 26)	2	
-3	030-309			. CAPACITOR, Ceramic, .33μF, 25V, -20+80% (C1-10)	10	
-4	014-387	∴		. TRANSISTOR, CD437 (Q1, 4, 18, 19)	4	
-5	580-080	∴		. TRANSISTOR, Dual (Q2, 5, 7, 11, 13, 14)	6	
-6	014-248	∴		. TRANSISTOR, CD37 (Q9, 10)	2	
-7	014-505	∴		. TRANSISTOR, CD445 (Q3, 6, 8, 12, 15)	5	
-8	580-081	∴		. TRANSISTOR, Dual (Q16, 20, 23, 25, 27)	5	
-9	014-506	∴		. TRANSISTOR, CD446 (Q17, 21, 24, 26, 28)	5	
-10	014-383	∴		. TRANSISTOR, CD441 (Q22, 29)	2	
-11	041-554			. RESISTOR, Carbon Composition, 51 Ohm, 1/4W, 5%	20	
				(R1, 7, 8, 17, 18, 22, 24, 28, 32, 34, 41, 43, 47, 50, 52, 58, ...		
				59, 66, 67, 73)		
-12	041-410			. RESISTOR, Carbon Composition, 1K Ohm, 1/4W, 5%	15	
				(R2, 9, 13, 16, 19, 25, 30, 40, 44, 49, 55, 57, 63, 64, 72)		
-13	041-429			. RESISTOR, Carbon Composition, 680 Ohm, 1/4W, ...	2	
				5% (R3, 62)		
-14	041-514			. RESISTOR, Carbon Composition, 9.1K Ohm, 1/4W, 5%	10	
				(R4, 11, 20, 27, 33, 42, 48, 54, 61, 70)		
-15	041-004			. RESISTOR, Carbon Composition, 220 Ohm, 1/2W, 5%	10	
				(R5, 10, 21, 29, 35, 39, 46, 53, 65, 71)		
-16	041-511			. RESISTOR, Carbon Composition, 3.9K Ohm, 1/4W, 5%	11	
				(R6, 12, 23, 31, 36, 38, 45, 51, 56, 60, 68)		
-17	041-430			. RESISTOR, Carbon Composition, 1.5K Ohm, 1/4W, ...	1	
				5% (R14)		
-18	041-505			. RESISTOR, Carbon Composition, 620 Ohm, 1/4W, ...	1	
				5% (R15)		
-19	041-584			. RESISTOR, Carbon Composition, 4.3K Ohm, 1/4W, ...	1	
				5% (R26)		
-20	041-550			. RESISTOR, Carbon Composition, 3K Ohm, 1/4W, ...	1	
				5% (R37)		
-21	041-413			. RESISTOR, Carbon Composition, 6.8K Ohm, 1/4W, ...	1	
				5% (R69)		
-22	041-408			. RESISTOR, Carbon Composition, 10K Ohm, 1/4W, ...	1	
				5% (R74)		
-23	280-130	∴		. PAD, Mounting, Transistor.	18	
-24	1363427-01			. PRINTED WIRING BOARD	1	



Figure 11-27. PWA Battery Charger (Board 3)

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
27	1363430-01			PRINTED WIRING ASSEMBLY BATTERY CHARGER BOARD . No. 3 (See Figure 25 For Next Higher Assembly)	Ref	
-1	586-024	∴		. CIRCUIT, Integrated (A1,2)	2	
-2	037-476			. CAPACITOR, Tantalum, 10μF, 25V, 10% (C1,5)	2	
-3	035-734			. CAPACITOR, Mylar, .01μF, 50V, 5% (C2,6)	2	
-4	030-057			. CAPACITOR, Ceramic, .01μF, 50V, 25% (C3,7)	2	
-5	034-286			. CAPACITOR, Mica, 200PF, 500V, 5% (C4,8)	2	
-6	014-505	∴		. TRANSISTOR, CD445 (Q1,2)	2	
-7	014-506	∴		. TRANSISTOR, CD446 (Q3,4)	2	
-8	058-021			. RESISTOR, Variable, 10K Ohm, 3/4W, 20% (R1,10,18)	3	
-9	041-408			. RESISTOR, Carbon Composition, 10K Ohm, 1/4W, ... 5% (R2,11)	2	
-10	048-137			. RESISTOR, Film, 10K Ohm, 1/2W, 1% (R3,4,12,13)	4	
-11	041-647			. RESISTOR, Carbon Composition, 75 Ohm, 1/4W, ... 5% (R5,14)	2	
-12	041-430			. RESISTOR, Carbon Composition, 1.5K Ohm, 1/4W, ... 5% (R6,15)	2	
-13	041-740			. RESISTOR, Carbon Composition, 200 Ohm, 1/4W, ... 5% (R7,16)	2	
-14	057-787			. RESISTOR, Film, 25.5 Ohm, 1/4W, 1% (R8,17).	2	
-15	057-678			. RESISTOR, Film, 750 Ohm, 1/4W, 1% (R9,19)	2	
-16	057-802			. RESISTOR, Film, 43.2K Ohm, 1/4W, 1% (R20)	1	
-17	058-008			. RESISTOR, Variable, 500 Ohm, 3/4W, 20% (R21)	1	
-18	048-259			. RESISTOR, Film, 1K Ohm, 1/4W, 1% (R22)	1	
-19	013-202	∴		. DIODE, Zener, 1N825 (VR1,2)	2	
-20	280-173	∴		. PAD, Mounting, Integrated Circuit	2	
-21	280-130	∴		. PAD, Mounting, Transistor	4	
-22	1363431-01			. PRINTED WIRING BOARD	1	



V8915

Figure 11-28. Battery Eliminator

BATTERY ELIMINATOR

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
28	1805258-02			BATTERY ELIMINATOR	Ref	
-1	1361596-01			. PRINTED WIRING ASSEMBLY (A1)	1	
-2	472-088			. SCREW, Machine, Xrecess, Pan Head, 2-56 x 3/16	4	
-3	126-183			. CIRCUIT BREAKER (CB1)	1	
-4	063-017			. CAPACITOR, Aluminum, 2000 μ F, 75Vdc (C1,2)	2	
-5	1361637-01			. BRACKET, Capacitor	1	
-6	471-273			. SCREW, Machine, Xrecess, Flat Head, 4-40 x 1/4	4	
-7	030-045			. CAPACITOR, Ceramic, 0.01 μ F, 1000V, 20% (C3,4)	2	
-8	173-562			. TERMINAL, Lug	2	
-9	143-783	..		. CONNECTOR, Receptacle, 9 Pin (J1)	1	
-10	502-023			. WASHER, Lock, #2	4	
-11	472-113			. SCREW, Machine, Xrecess, Pan Hd	4	
-12	492-007			. NUT, Plain, Hex, 2-56	4	
-13	1361638-01			. BRACKET, Connector	1	
-14	471-274			. SCREW, Machine, Xrecess, Flat Head, 4-40 x 5/16	4	
-15	1380163-01			. COVER, Connector Bracket	1	
-16	470-469			. SCREW, Cap, Hex Socket, Button Head, 2-56 x 3/16	2	
-17	143-790	..		. CONNECTOR, Receptacle, PC, 10 Pin Dual (J2)	1	
-18	018-027			. ADHESIVE	AR	
-19	470-471			. SCREW, Cap, Hex Socket, Button Head, 4-40 x 5/16	2	
-20	014-627			. TRANSISTOR, Silicon, PNP (Q1-3)	3	
-21	087-063			. GREASE, Silicon	AR	
-22	600-243			. SLEEVING, Teflon	AR	
-23	476-251			. SCREW, Self-Tapping, Xrecess, Pan Head, #6 x 5/8	6	
-24	470-476			. SCREW, Cap, Hex Socket, Button Head, 4-40 x 1/2	6	
-25	496-004			. NUT, Assembled Washer, 4-40	6	
-26	501-637			. WASHER, Flat, #4	6	
-27	014-614			. TRANSISTOR, Silicon, NPN (Q4)	1	
-28	087-063			. GREASE, Silicon	AR	
-29	600-243			. SLEEVING, Teflon	AR	
-30	476-251			. SCREW, Self-Tapping, Xrecess, Pan Head, #6 x 5/8	2	
-31	470-476			. SCREW, Cap, Hex Socket, Button Head, 4-40 x 1/2	2	
-32	496-004			. NUT, Assembled Washer, 4-40	2	
-33	501-637			. WASHER, Flat, #4	2	
-34	150-142	..		. MOUNTING Kit, Transistor	4	
-35	043-581			. RESISTOR, Wirewound (R1,2)	2	
-36	173-004			. TERMINAL, Turret	2	
-37	120-222	..		. SWITCH, Toggle, DPDT (S1)	1	
-38	1380174-01			. TRANSFORMER, Power (T1)	1	
-39	471-077			. SCREW, Machine, Pan Head, Xrecess, 8-32 x 5/16	4	
-40	501-004			. WASHER, Flat, #8	4	
-41	1363438-01			. COVER	2	
-42	471-063			. SCREW, Machine, Pan Head, Xrecess, 4-40 x 7/16	4	
-43	502-024			. WASHER, Lock, #4	4	
-44	1361620-02			. HEATSINK, Battery Eliminator	1	
-45	018-027			. ADHESIVE	AR	
-46	470-475			. SCREW, Machine, Hex Socket, Button Head, 6-32 x 1/2	4	
-47	1363383-01			. WIRING HARNESS		
-48	302-076	..		. CLAMP, Cable, 0.375 I.D.	1	
-49	506-013			. WASHER, "D", Cable Clamp, #6	1	
-50	502-025			. WASHER, Lock, #6	1	
-51	471-069			. SCREW, Machine, Xrecess, Pan Head, 6-32 x 3/8	1	
-52	1361646-01			. CAPACITOR BOARD	1	
-53	471-010			. SCREW, Machine, Xrecess, Pan Head, 4-40 x 1/4	2	
-54	496-004			. NUT, Assembled Washer, 4-40	2	
-55	6000035-01			. LABEL, Identification	1	
-56	171-006			. TERMINAL, Lug	2	
-57	1361636-01			. CASE, Battery Eliminator	1	

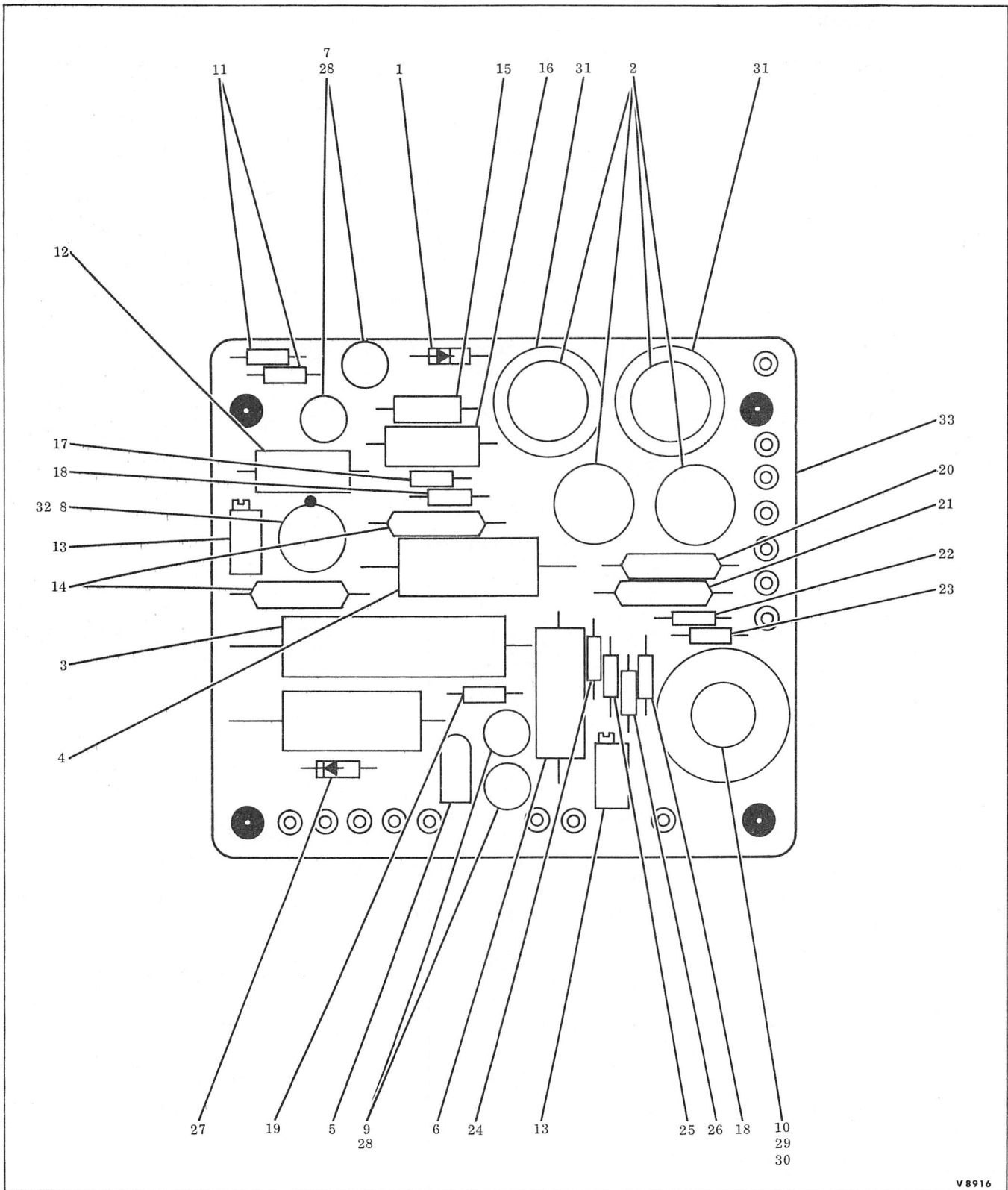


Figure 11-29. PWA Battery Eliminator

PRINTED WIRING ASSEMBLY

FIG. & INDEX NO.	PART NUMBER	*	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
29	1361596-01			PRINTED WIRING ASSEMBLY (BATTERY ELIMINATOR) . .	Ref	
-1	013-599	∴		. DIODE, CD458 (CR1)	1	
-2	580-065	∴		. DIODE, 1N4998 (CR2-5)	4	
-3	037-442			. CAPACITOR, Tantalum, 140μF, 60V, 20% (C1)	1	
-4	037-117			. CAPACITOR, Tantalum, 150μF, 30V, 20% (C2,3)	2	
-5	037-630			. CAPACITOR, Tantalum, 27μF, 15V, 10% (C4)	1	
-6	037-049			. CAPACITOR, Tantalum, 22μF, 35V, 20% (C5)	1	
-7	014-387	∴		. TRANSISTOR, CD437 (Q1,2)	2	
-8	014-597			. TRANSISTOR, Dual, CD474 (Q3)	1	
-9	014-951			. TRANSISTOR, 2N4413A (Q4,5)	2	
-10	014-678	∴		. TRANSISTOR, CD513 (Q6)	1	
-11	041-520			. RESISTOR, Carbon Composition, 7.5K Ohm, 1/4W, . . . 5% (R1,2)	2	
-12	041-457			. RESISTOR, Carbon Composition, 390 Ohm, 1W, 5% (R3) .	1	
-13	058-286			. RESISTOR, Variable, 500 Ohm, 1W, 5% (R4,20)	2	
-14	057-453			. RESISTOR, Film, 4.99K Ohm, 1/4W, 1% (R5,10)	2	
-15	041-007			. RESISTOR, Carbon Composition, 750 Ohm, 1/2W, 5% (R6).	1	
-16	041-269			. RESISTOR, Carbon Composition, 360 Ohm, 1W, 5% (R7) .	1	
-17	041-570			. RESISTOR, Carbon Composition, 2.4K Ohm, 1/4W, . . . 5% (R8)	1	
-18	041-413			. RESISTOR, Carbon Composition, 6.8K Ohm, 1/4W, . . . 5% (R9,19)	2	
-19	041-550			. RESISTOR, Carbon Composition, 3K Ohm, 1/4W, ... 5% (R11)	1	
-20	057-649			. RESISTOR, Film, 3.65K Ohm, 1/4W, 1% (R12)	1	
-21	057-917			. RESISTOR, Film, 5.76K Ohm, 1/4W, 1% (R13)	1	
-22	041-410			. RESISTOR, Carbon Composition, 1K Ohm, 1/4W, 5% (R14).	1	
-23	041-484			. RESISTOR, Carbon Composition, 120K Ohm, 1/4W, . . . 5% (R15)	1	
-24	041-514			. RESISTOR, Carbon Composition, 9.1K Ohm, 1/4W, . . . 5% (R16)	1	
-25	041-442			. RESISTOR, Carbon Composition, 2.7K Ohm, 1/4W, . . . 5% (R17)	1	
-26	041-429			. RESISTOR, Carbon Composition, 680 Ohm, 1/4W, ... 5% (R18)	1	
-27	013-307	∴		. DIODE, Zener, 1N941 (VR1)	1	
-28	280-130	∴		. PAD, Transistor (Q1,2,4,5)	4	
-29	280-998	∴		. PAD, Transistor (Q6)	1	
-30	435-993	∴		. HEATSINK, Transistor (Q6)	1	
-31	014-362	∴		. HEATSINK (CR2,4)	2	
-32	014-712	∴		. PAD, Transistor (Q3)	1	
-33	1361597-01			. PRINTED WIRING BOARD	1	

NUMERICAL INDEX

1809993

VR-3000 VIDEO TAPE RECORDER

PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART
013-166	19-58	1	014-070	9-71	2	014-506	17-19	2
013-167	3-36	1	014-247	9-20	2		19-20	4
013-202	12-71	2		16-13	1		20-32	21
	16-46	4		22-24	4		21-37	19
	27-19	2		23-4	1		22-23	11
013-224	9-66	2	014-248	12-24	1		26-9	5
	17-45	1		16-14	1		27-7	2
013-257	9-67	1		22-29	3	014-581	4-26	1
	11-40	3		23-3	10		5-26	1
	21-68	2		26-6	2		6-26	1
013-358	9-65	1	014-353	22-31	2		7-26	1
013-455	20-3	1	014-354	20-33	2		8-24	1
013-599	10-4	1		22-30	2		9-18	2
	16-2	7	014-364	9-26	1		20-34	1
	18-1	6		10-12	1	014-590	19-19	1
	24-85	1		15-8	7	014-597	16-19	2
	24-272	4		16-21	1	014-600	12-21	3
013-625	3-35	1		17-18	1		14-22	3
	19-57	1		22-27	1	014-614	24-319	4
013-677	22-1	4		23-5	1	014-617	9-23	1
013-678	10-2	2	014-383	9-24	1	014-627	24-318	1
	24-273	1		16-15	3	014-628	16-18	2
	24-317	6		17-17	1	014-629	16-11	2
	25-9	2		26-10	2	014-672	19-22	3
	25-55	20	014-387	9-19	1	014-678	10-10	1
	26-2	2		16-20	1	014-715	9-70	14
013-689	3-3	1		26-4	4	014-720	24-163	2
	4-4	11	014-505	3-16	2	014-723	19-21	1
	5-4	14		4-27	3	014-783	12-76	1
	6-4	15		5-27	3		19-65	3
	7-4	14		6-27	3	014-833	24-165	4
	8-4	13		7-27	3	014-847	9-69	2
	9-2	7		8-25	3	014-850	22-28	1
	10-3	5		9-22	3	014-852	12-25	1
	11-8	7		10-14	1		22-26	4
	12-3	6		10-15	1	014-914	16-50	8
	13-5	5		11-21	1	014-947	10-11	1
	14-3	5		12-22	4		24-164	2
	15-1	36		13-28	1	014-948	17-12	1
	17-2	14		14-21	5	014-949	9-25	1
	19-2	2		16-16	3	014-950	19-23	2
	20-1	2		17-11	3	014-954	22-84	5
	21-8	2		20-31	2	014-960	25-30	10
	22-3	2		22-25	3	014-961	25-34	10
	23-1	3		23-6	9	018-010	25-46	AR
	26-1	26		26-7	5	018-027	25-6	AR
013-723	20-2	12		27-6	2		25-65	AR
	21-7	2	014-506	3-17	3		25-76	AR
	22-2	2		4-28	3		25-82	AR
013-829	25-54	20		5-28	3	020-407	16-48	1
013-855	25-4	1		6-28	3		18-5	4
013-884	9-3	1		7-28	3		24-277	1
013-910	16-1	6		8-26	3	020-467	4-24	1
013-982	9-61	1		9-21	5		5-24	1
013-983	12-72	1		10-13	3		6-24	1
	15-28	1		11-19	11		7-24	1
	19-59	2		12-23	9		8-22	1
	23-18	1		13-27	8	020-511	9-15	2
014-057	11-20	1		14-20	7	020-562	3-13	1
	22-32	1		15-7	20		19-18	1
				16-17	2			

NUMERICAL INDEX

1809993

VR-3000 VIDEO TAPE RECORDER

PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART
020-563	16-10	1	034-359	20-5	1	035-840	13-9	1
	18-3	4	034-360	20-8	1		16-9	1
	24-276	1	034-363	12-18			17-8	3
030-057	27-4	2	034-416	20-12	2		20-21	1
030-144	3-7	1	034-571	22-13	2		21-9	9
	19-4	3	034-768	4-6	1		22-8	4
030-163	3-5	1		7-6	1	035-841	11-7	1
030-212	22-5	13	034-770	5-6	1		12-5	4
030-224	22-6	4		6-6	1		13-8	3
030-295	19-16	1	034-773	4-5	1		14-4	5
030-309	26-3	10		7-5	1	035-842	16-5	1
030-451	22-4	8	034-774	5-5	1	035-843	4-17	1
030-495	3-4	1		6-5	1		5-17	1
	19-5	2	034-775	4-8	1		6-17	1
030-576	9-9	1	034-777	5-7	1		7-17	1
	24-316	2		6-7	1		8-15	1
030-789	19-17	1		7-7	1	035-844	21-10	2
030-819	13-19	2		8-5	1	035-853	13-22	1
030-829	3-11	1	034-778	5-8	1	035-854	21-15	1
	19-7	3		6-8	1	035-858	12-8	1
030-871	12-4	2		7-8	1	035-883	11-12	2
030-879	14-19	1		8-6	1		12-20	1
030-880	19-10	2	034-779	4-7	1		13-21	1
030-881	19-15	2	034-788	21-17	8		14-17	1
030-883	4-20	1	034-930	21-20	1		22-7	10
	5-20	1	034-945	4-9	2	035-893	12-12	1
	6-20	1		5-9	2		14-8	2
	7-20	1		6-9	2	037-028	19-3	3
	8-18	1		7-9	2	037-035	19-6	4
	17-7	1		8-7	2	037-058	3-12	1
030-884	19-12	1	034-962	4-13	1		16-6	2
030-885	3-10	2		5-13	1		22-11	3
	19-13	1		6-13	1	037-068	4-10	2
031-390	15-3	1		7-13	1		5-10	2
031-933	25-12	2		8-11	1		6-10	2
034-156	21-26	1	035-582	12-6	1		7-10	2
034-181	4-11	1	035-598	21-18	1		8-8	2
	5-11	1	035-729	14-13	1		9-6	2
	6-11	1	035-734	27-3	2	037-071	22-14	1
	7-11	1	035-814	12-9	2	037-085	4-14	1
	8-9	1	035-815	4-19	1		5-14	1
034-182	9-12	1		5-23	1		6-14	1
034-208	12-10	3		6-23	1		7-14	1
	13-23	2		7-23	1		8-12	1
	14-9	6		8-21	1	037-094	24-274	1
034-212	4-12	1	035-816	13-14	1	037-107	19-11	1
	5-12	1	035-817	4-19	1	037-109	19-8	4
	6-12	1		5-19	1	037-117	16-7	4
	7-12	1		6-19	1	037-136	17-3	2
	8-10	1		7-19	1	037-138	15-4	4
034-215	9-4	1		8-17	1	037-153	17-6	1
034-235	12-17	2		21-19	3	037-160	15-2	1
034-240	9-13	1	035-828	4-16	1	037-222	23-2	1
034-248	21-24	1		5-16	1	037-223	24-311	1
034-254	12-16	1		6-16	1	037-241	18-2	4
034-286	10-8	1		7-16	1	037-256	19-9	1
	14-5	2		8-14	1	037-380	9-7	1
	17-9	1		9-14	1	037-426	11-14	1
	27-5	2	035-837	13-24	2		13-17	1
034-297	21-22	1		16-3	4		20-19	1
034-327	21-25	1		20-20	37		21-13	1
034-343	21-23	1		21-12	5	037-436	9-5	2
034-347	14-12	1	035-839	16-4	2		11-13	4
034-350	20-13	1	035-840	10-6	3		12-13	7
	21-21	2		12-14	2		13-16	5

NUMERICAL INDEX

1809993

VR-3000 VIDEO TAPE RECORDER

PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART
037-436	14-11	3	041-408	11-31	2	041-413	14-34	1
	15-5	1		12-26	5		16-40	1
	20-15	6		13-54	2		20-62	6
	21-11	2		14-25	7		22-37	3
	22-10	3		15-17	3		26-21	1
037-439	11-18	2		16-39	2	041-414	5-38	1
	12-15	1		17-42	1		6-38	1
037-455	24-248	1		19-39	1		7-38	1
037-462	9-10	1		20-43	2		8-32	1
	12-19	2		21-39	3		12-53	2
	17-4	1		22-56	2		13-56	2
037-463	13-18	2		26-22	1		14-37	3
	20-14	1		27-9	2		19-30	3
	21-16	1	041-409	4-50	1		20-39	11
	22-13	3		5-51	1		23-10	10
037-476	11-11	1		6-51	1	041-415	14-50	2
	14-15	1		7-50	1	041-417	17-26	1
	15-6	1		8-44	1		20-64	2
	16-8	2		10-26	1		21-49	5
	21-14	1		12-35	1	041-418	16-33	2
	27-2	2		13-48	1	041-419	3-20	2
037-519	11-10	2		17-43	1		11-23	1
	13-20	1	041-410	3-24	3		12-40	3
	20-22	1		4-59	1		13-55	1
	22-9	1		5-60	1		14-23	5
037-522	9-11	1		6-60	1		20-36	20
037-617	3-8	1		7-61	1		21-50	4
037-630	14-16	1		8-55	1		22-34	5
037-985	19-14	1		9-55	1		23-9	1
038-115	20-24	1		10-23	3	041-425	13-32	4
041-004	26-15	10		11-29	4		17-22	1
041-007	23-17	3		12-49	4		20-40	1
041-013	23-15	6		13-49	15		21-44	1
041-020	24-275	1		14-33	6		22-33	8
041-023	17-20	1		15-23	1	041-427	11-36	1
041-256	20-61	2		16-31	4		12-63	1
041-317	20-58	2		17-35	3		15-21	1
	23-16	3		20-48	10		20-53	4
041-323	4-47	1		21-41	12	041-428	3-21	1
	5-47	1		22-36	3		4-53	1
	6-47	1		26-12	15		5-54	1
	7-47	1	041-411	3-28	2		6-54	1
	8-41	1		11-28	1		7-54	1
041-334	24-86	1		12-34	5		8-48	1
041-393	12-64	1		15-14	1		9-51	1
041-394	10-28	2		16-28	2		11-26	12
	14-29	9	041-412	4-42	1		12-51	4
	15-16	3		5-42	1		13-36	1
	16-29	2		6-42	1		14-40	2
	17-21	1		7-42	1		20-41	3
041-396	22-55	1		8-36	1		22-73	1
041-406	13-42	2		11-34	2		23-8	15
	20-37	1		12-55	1	041-429	12-47	1
041-407	10-25	3		14-31	3		20-50	1
	13-40	3		16-34	3		21-57	1
	14-51	1		21-66	2		26-13	2
	19-27	1		23-11	2	041-430	4-61	2
	20-54	3	041-413	4-38	1		5-62	2
041-408	6-53	1		6-59	2		6-62	2
	8-47	1		8-54	1		7-63	2
	9-43	2		11-37	1		8-57	2
	10-27	1		12-50	2		12-28	3

NUMERICAL INDEX

1809993

VR-3000 VIDEO TAPE RECORDER

PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART
041-430	13-38	4	041-504	3-30	1	041-550	9-52	3
	14-24	4		4-56	1		11-25	3
	16-27	2		5-57	1		13-37	1
	19-31	2		6-57	1		14-41	2
	21-62	2		7-57	1		15-10	23
	22-70	2		8-51	1		16-26	8
	26-17	1		10-16	1		17-44	1
	27-12	2		13-52	2		22-72	2
041-432	12-41	1		17-27	1		23-14	6
	17-41	2		23-13	2		26-20	1
041-434	4-46	1	041-505	12-30	2	041-554	11-32	2
	5-46	1		26-18	1		12-65	1
	6-46	1	041-506	16-25	4		21-47	9
	7-46	1		20-60	1		26-11	20
	8-40	1		21-60	3	041-559	12-43	1
	9-34	1	041-507	10-30	1	041-560	9-47	1
	15-27	1	041-508	3-27	2		10-22	1
	23-7	1		7-53	1		22-35	7
041-436	9-53	1		9-46	1	041-561	4-49	6
	15-11	2		12-68	2		5-50	6
	19-50	1		16-38	2		6-50	6
041-437	4-62	1		17-23	1		7-49	6
	5-63	1		19-26	5		8-43	6
	6-63	1	041-511	17-40	1		12-54	6
	7-64	1		19-46	1		13-43	1
	8-58	1		22-39	1		15-9	2
	9-30	1		26-16	11		17-36	1
	15-18	1	041-514	4-58	2	041-563	19-44	1
	20-46	1		5-59	2	041-569	20-35	1
	22-75	1		7-59	1		21-61	2
041-438	10-24	2		8-53	1	041-570	4-48	1
041-440	13-41	1		13-51	2		5-49	1
	16-41	2		26-14	10		6-49	1
	20-56	4	041-519	10-29	1		7-48	1
	21-52	1		17-33	1		8-42	1
	22-69	1	041-520	12-67	1		22-76	1
041-442	13-50	1		17-38	3	041-573	4-55	1
	20-45	1	041-530	12-66	2		5-56	1
041-461	22-51	1	041-531	21-43	5		6-56	1
041-469	14-30	1	041-532	4-45	2		7-56	1
041-482	7-60	1		5-45	2		8-50	1
	9-35	3		6-45	2	041-574	15-26	1
	16-42	2		7-45	2	041-576	12-36	1
	17-31	2		8-39	2	041-584	12-42	1
041-483	9-48	1	041-537	21-53	1		16-30	4
	14-45	1	041-538	9-42	1		26-19	1
	15-13	8		12-69	2	041-612	12-27	2
041-495	4-57	1		14-35	6	041-631	16-12	4
	5-58	1		15-19	2	041-647	4-39	2
	6-58	1		16-36	1		5-39	2
	7-58	1		17-32	2		6-39	2
	8-52	1	041-543	11-27	1		7-39	2
	12-45	1	041-549	4-52	2		8-33	2
	13-45	1		5-53	2		20-52	2
	15-15	3		7-52	1		21-67	2
	22-38	1		8-46	1		22-68	2
041-496	3-29	2		15-20	2		27-11	2
	19-28	3		16-43	1	041-651	9-37	2
	22-49	4	041-550	3-25	1		14-32	3
	24-249	1		4-51	1		20-44	5
041-497	9-36	1		5-52	1		21-45	8
041-503	13-58	1		6-52	1		22-48	10
	17-24	1		7-51	1		23-12	2
	20-57	3		8-45	1			
	21-55	1						

NUMERICAL INDEX

1809993

VR-3000 VIDEO TAPE RECORDER

PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART
041-652	17-25	2	048-621	20-38	1	055-166	7-21	3
	22-59	2	048-625	9-39	2		8-19	3
041-653	13-53	1	048-715	22-61	2		13-15	2
041-684	21-48	4	048-810	5-29	2	055-167	13-7	2
041-738	9-44	1		6-29	2		14-18	1
	10-21	1	048-821	4-43	1	055-200	4-15	1
	20-42	2	048-840	4-33	1		5-15	1
	21-56	1	048-842	5-35	1		6-15	1
041-739	20-63	1		6-35	1		7-15	1
041-740	14-42	1		7-35	1		8-13	1
	16-32	4		8-29	1	055-447	24-44	1
	21-51	1	048-844	5-33	1		24-140	1
	27-13	2		6-33	1	055-581	9-8	1
041-742	19-35	1		7-33	1		11-9	1
041-743	11-35	1		8-27	1		13-13	1
	20-47	1	048-845	4-35	1		14-10	1
041-744	20-51	2	048-847	4-34	1	055-582	11-16	1
041-750	4-44	1	048-848	5-36	2		12-11	1
	5-44	1		6-36	2		13-6	3
	6-44	1		7-36	2	055-604	4-22	1
	7-44	1		8-30	2		5-22	1
	8-38	1	048-850	5-34	1		6-22	1
	9-56	1		6-34	1		8-20	1
	16-37	2		7-34	1	055-607	10-5	2
041-751	15-12	9		8-28	1	055-608	17-5	1
	17-39	2	048-854	4-36	2	055-609	10-7	1
041-753	4-60	1	048-860	22-63	2	056-022	20-16	1
	5-61	1	048-875	22-50	2	056-161	14-6	2
	6-61	1	048-943	22-52	1	056-162	12-7	3
	7-62	1	048-962	5-30	1	056-163	11-15	1
	8-56	1		6-30	1		13-12	1
041-757	17-34	1	049-401	22-46	4	056-271	20-10	1
041-758	15-25	1	049-402	22-42	4	056-272	20-6	1
041-761	13-57	1	049-404	22-45	4	056-273	20-4	1
	19-43	2	049-405	22-43	4	056-274	20-23	1
041-768	19-38	1	049-408	22-40	4	056-275	20-18	1
041-770	19-53	1	051-166	20-25	3	056-276	20-17	1
041-771	3-26	1	051-281	9-16	1	056-277	20-11	1
041-778	12-70	1	051-334	20-26	1	056-278	20-7	1
	19-52	1		21-35	1	056-279	20-9	1
041-781	9-54	1	051-363	21-36	1	056-281	22-67	1
041-973	21-54	1	051-369	21-34	1	056-282	22-77	1
042-456	5-48	1	051-386	21-33	1	056-283	22-71	2
	6-48	1	051-411	22-17	8	056-284	22-44	5
042-809	22-47	18	051-484	21-32	1	056-285	22-53	1
043-380	16-35	2	051-569	3-15	2	056-286	22-54	1
043-581	24-161	2	051-633	3-14	1	056-287	22-66	1
043-682	9-63	1	051-634	10-9	2	056-288	22-41	4
043-741	17-29	1		17-10	2	057-068	4-37	2
043-974	9-60	1	055-131	13-11	2		5-37	2
047-427	17-28	1	055-135	14-14	4		6-37	2
047-859	9-38	1	055-144	4-18	1		7-37	2
047-890	4-32	1		5-18	1		8-31	2
	7-32	1		6-18	1	057-071	4-54	1
047-891	9-31	1		8-16	1		5-55	1
048-137	27-10	4		13-10	1		6-55	1
048-259	22-60	2		14-7	1		7-55	1
	27-18	1	055-158	24-162	2		8-49	1
048-457	5-32	1	055-166	4-21	3	057-072	22-62	2
	6-32	1		5-21	3	057-074	9-28	1
048-499	22-74	1		6-21	3	057-076	9-40	1
							20-49	2

NUMERICAL INDEX

VR-3000 VIDEO TAPE RECORDER

1809993

PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART
057-079	24-112	2	057-132	21-58	1	058-330	10-31	1
057-081	12-58	1	057-134	19-49	4		17-30	2
	24-45	1	057-138	13-39	1	058-333	3-23	1
	24-141	1	057-143	12-37	1		19-32	1
057-082	21-40	4	057-144	11-24	1	058-335	19-55	1
057-083	19-34	1	057-238	5-43	1	058-347	3-18	2
	20-55	1		6-43	1	058-350	24-64	1
057-084	22-64	2		7-43	1	058-351	24-14	1
057-088	12-61	1		8-37	2	058-372	12-33	1
057-089	9-29	1	057-380	4-31	1	059-222	10-19	1
	12-57	1		7-31	1	059-223	18-4	2
057-096	4-41	1	057-448	4-29	2	059-224	15-24	1
	5-41	1		7-29	2	059-225	9-32	2
	6-41	1	057-453	19-25	2	059-226	15-22	1
	7-41	1	057-678	27-15	2	059-228	10-17	1
	8-35	1	057-759	9-61	2	059-229	10-20	1
	12-62	1	057-787	27-14	2	059-230	10-18	1
	13-34	2	057-802	27-16	1	059-246	25-56	20
	16-24	4	057-960	12-39	FS	062-006	12	FS
057-097	4-40	1	057-961	12-29	FS	062-007	12	FS
	5-40	1		12-46	1	062-008	12	FS
	6-40	1	057-962	12-31	1	062-009	12	FS
	7-40	1	057-963	12-38	1	062-010	12	FS
	8-34	1	057-964	14	FS	062-011	12	FS
057-098	16-23	4	057-965	12-38	1	062-012	12	FS
057-100	3-33	1	057-966	14-47	1	062-013	12	FS
057-102	19-40	1	057-967	11-39	1	062-014	12	FS
057-103	19-45	1		12-48	1	062-015	12	FS
	24-113	1		14-44	1	062-016	12	FS
057-104	3-33	1	057-968	14-46	1	062-017	12	FS
	14-49	1	057-969	13-31	2	062-018	12	FS
057-105	9-33	1	057-970	11-33	1	062-019	12	FS
057-106	21-42	1	057-971	12-44	1	062-020	12	FS
057-108	9-50	1	057-972	14-36	1	062-021	12	FS
	19-33	2	057-973	14-26	1	062-022	14-27	FS
057-109	19-37	1	057-974	14-43	1	062-023	14	FS
057-110	19-36	1	057-977	22-65	2	062-024	14	FS
057-113	3-32	1	057-978	4-30	1	062-025	14	FS
	12-56	1		7-30	1	062-026	14	FS
	13-35	1		9-41	1	062-027	14	FS
	14-39	1	057-979	9-62	2	062-028	14	FS
	19-29	1	057-980	9-59	1	062-029	14	FS
057-114	19-47	2	057-981	9-58	1	087-388	25-33	AR
057-115	9-49	1	058-008	27-17	1	089-054	25-67	1
057-118	14-48	1	058-021	27-8	3	089-056	24-155	1
057-119	21-46	4	058-124	3-22	1	090-133	25-29	1
057-120	9-45	1		19-24	1	103307-02	25-57	40
	12-60	1	058-266	22-57	3	120-122	24-88	1
	14-38	8	058-273	19-48	2		24-282	2
	19-54	2	058-318	9-27	1	123-223	25-41	1
	24-46	2	058-319	12-32	2	120-828	25-35	1
	24-142	2		14-28	1	120-869	24-105	5
057-121	11-30	1		16-22	4	1211910-10	24-198	1
057-122	12-52	1		21-65	1	1212228-01	21-27	1
	13-33	1		22-58	1	122-257	24-111	1
	13-46	1	058-321	11-22	1	122-322	24-114	1
	21-64	2		13-29	2	1232639-01	24-126	1
057-124	19-41	3	058-322	20-65	1	1232645-01	24-128	1
057-125	21-59	1		21-63	2	1241512-01	21-38	1
057-127	12-59	1	058-323	13-30	1		22-22	8
	19-51	2	058-324	24-94	4	126-162	25-7	1
057-128	13-44	1	058-328	20-59	1	126-178	24-28	1
057-131	13-47	1	058-329	17-37	1	132-144	24-65	1
	19-42	1				132-145	24-24	1
057-132								

NUMERICAL INDEX

1809993

VR-3000 VIDEO TAPE RECORDER

PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART
132-146	25-17	2	1361592-01	2-14	1	1361684-02	24-331	1
132-147	25-18	2		19	Ref	1361684-03	24-333	1
132-148	24-12	1	1361593-02	19-66	1	1361685-01	24-329	1
1360036-01	4-65	1	1361610-01	24-235	1	1361686-01	24-308	1
	5-66	1	1361611-02	24-336	1	1361686-02	24-309	1
	6-66	1	1361612-01	24-288	1	1361693-01	2-2	1
	7-67	1	1361613-01	24-286	1	1361693-02	2	1
	8-61	1	1361614-01	24-290	1	1361693-03	2	1
1360186-01	24-210	2	1361615-01	24-297	1	1361693-04	2	1
1361508-01	24-2	2	1361617-01	22-79	1	1361693-05	2	1
1361509-05	24-59	3	1361618-01	24-123	1	1361695-01	24-67	1
	24-61	1	1361619-01	24-224	2	1361696-01	24-68	1
1361510-02	24-1	2	1361621-01	24-200	1	1361697-01	24-241	1
1361513-01	24-132	1	1361625-03	24-39	1	1361698-01	24-118	1
1361520-01	24-152	1	1361626-03	24-135	1	1361700-01	24-209	2
1361539-01	24-22	1	1361627-01	24-51	1		24-240	2
1361549-01	24-19	1	1361627-02	24-148	1	1361701-01	24-244	3
1361550-02	2-29	1	1361628-01	24-52	1	1361702-01	24-220	5
	24	Ref		24-147	1	1361703-01	25-13	1
1361556-01	2-18	1	1361629-01	24-58	1	1361704-02	24-227	1
	23	Ref	1361630-01	24-50	1	1361713-01	24-245	1
1361557-01	23-21	1		24-146	1	1361714-01	24-95	1
1361558-01	2-6	1	1361631-03	24	1	1361720-01	24-315	1
	11	Ref	1361631-04	24	1	1361721-01	24-10	1
1361559-02	11-45	1	1361632-01	24-55	1	1361724-01	24-211	1
1361560-02	2-7	1	1361633-01	24-151	1	1361727-01	2-39	1
	12	Ref	1361634-01	24-21	1	1361729-01	2-35	1
1361561-03	12-77	1	1361640-01	24-82	1	1361730-01	2-37	2
1361562-01	14	Ref	1361641-01	24-92	1	1361731-01	24	1
1361563-02	14-55	1	1361644-01	24-26	1	1361732-01	24-47	1
1361564-01	2-8	1	1361651-01	24-77			24-143	1
	13	Ref	1361652-01	24-78		1361735-01	24-15	1
1361565-01	13-62	1		24-81		1361736-01	24-203	1
1361566-01	2-10	1	1361653-01	24	1	1361738-01	2-13	1
	15	Ref	1361654-01	24-80	1		18	Ref
1361567-02	15-31	1	1361655-01	24	1	1361739-01	18-6	1
1361576-02	2-17	1	1361657-01	2-3	1	1361748-01	24-195	1
	22	Ref		4	Ref	1362928-01	24-278	1
1361577-02	22-85	1	1361657-02	2	Ref	1362929-01	24	1
1361578-01	2-16	1		5	Ref	1363322-03	24-169	1
	21	Ref	1361657-03	2	1	1363322-04	24-174	1
1361579-01	21-73	1		6	Ref	1363338-01	20-70	1
1361580-01	2-15	1	1361657-04	2	1	1363347-01	24-76	2
	20	Ref		7	Ref	1363364-01	24-35	1
1361581-02	20-71	1	1361657-05	2	1	1363367-01	2	1
1361582-02	2-4	1			Ref	1363378-01	24-27	1
	9	Ref	1361661-01	24-66	1	1363382-02	25-61	1
1361583-02	9-73	1	1361662-02	25-85	1	1363385-01	24-72	1
1361585-01	4-67	1	1361663-01	25-63	1	1363396-02	24-166	1
	5-68	1	1361665-01	25-66	1	1363398-01	24-294	1
	6-68	1	1361668-01	25-62	1	1363399-01	2-19	1
	7-69	1	1361669-01	25-48	2	1363400-01	2-32	9
	8-63	1	1361670-01	25-47	2	1363403-01	2-21	1
1361588-01	2-11	1	1361671-01	25-49	2	1363409-01	2-27	1
	16	Ref	1361677-01	24-33	1	1363410-01	2-28	1
1361589-03	16-53	1	1361678-01	24-120	2	1363426-01	25-1	2
1361590-01	2-1	1	1361680-01	24-37	1		26	Ref
	3	Ref	1361681-01	24-133	1	1363427-01	26-24	1
1361591-01	3-41	1	1361684-01	24-327	1	1363430-01	25-2	1
							27	Ref

NUMERICAL INDEX

1809993

VR-3000 VIDEO TAPE RECORDER

PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART
1363431-01	27-22	1	148-027	16-45	2	280-998	15-30	7
1363432-01	25-52	1	148-028	3-34	1		16-51	2
1363433-01	25-53	1		16-44	2		17-48	1
1363441-01	24-71	1	148-038	24-32	17		19-63	2
1363474-01	24-279	1	148-039	24-30	1		22-83	6
1363588-01	25-3	1	148-042	24-31	2		23-20	2
1353640-01	3-39	1	169-318	25-23	2	302-006	25-69	1
	19-62	1	171-006	25-11	2	302-074	24-190	1
1363652-02	24-54	1	171-007	25-77	6	302-076	24-313	1
	24-150	1	172-004	24	4	302-080	24-262	1
1363653-02	24	1		24-259	1	310-042	25-73	2
1363716-01	24-193	1		24-270	1	310-245	25-84	4
1363796-01	2-5	1		24-325	8	310-512	25-83	4
	10	Ref	172-038	24-185	1	310-515	24-16	1
1363797-01	10-35	1	173-004	24-87	3	352-006	24-83	2
1363799-01	2-12	1		24-254	1	406-022	24-93	1
	17	Ref	1805275-02	25	Ref	406-024	24-79	1
1363800-01	17-53	1	1805278-02	2	Ref	4100157-10	24-75	1
1363802-01	17-49	1	205-027	24-66	1	430-230	24-20	2
1363803-01	24-7	1	251-091	20-69	1	435-993	16-52	2
1363806-01	24-6	1		21-72	1	4580197-01	19-56	1
1363810-01	2-49	1	260-052	25-45	AR	460-124	24-17	4
1363811-01	2	1	269-028	25-78	AR	470-009	24-246	4
1363816-01	2-46	4	269-302	24-18	AR	470-010	24-8	8
1363817-01	2-41	2	280-046	24	1		24-40	2
1363820-01	24-335	1	280-100	11-43	12		24-69	8
1363821-01	24-115	1		12-75	17		24-121	2
1363822-01	24-109	5		13-61	9		24-136	2
1363822-02	24-110	5		14-54	15		24-153	3
1363823-01	24-101	1		20-68	26	470-012	24-124	2
1363823-02	24-100	1		21-71	23	470-015	24-292	1
1363823-03	24-99	1		22-82	29	470-017	24-280	1
1363823-04	24-98	1		23-19	19	470-029	24-156	2
1363823-05	24-97	1	280-130	3-40	5	470-039	24-129	1
1363844-01	24-102	5		4-66	7	470-460	24-34	1
1380144-01	24-291	1		5-67	7		24-36	2
1380150-01	24-53	1		6-67	7		24-38	1
	24-149	1		7-68	7		24-119	2
1380165-01	24-225	1		8-62	7		24-134	1
1380165-02	24-226	1		10-34	4	470-470	24-11	2
1380168-01	24-179	1		15-29	20		24-96	2
1380168-02	24-180	1		16-47	16	470-471	25-64	6
1380176-01	25-38	1		17-47	6	470-474	24-116	2
1380177-01	25-28	1		19-64	6	470-475	2-30	9
1380181-02	25-43	1		26-23	18	470-481	24-73	2
1380190-01	20-66	1		27-21	4	471-011	10	2
1380190-02	20-67	1	280-173	4-64	2	471-059	24-42	2
1380204-01	24-301	1		5-65	2	471-060	24-138	2
142-026	24-182	3		6-65	2		24-268	2
143-198	24-217	2		7-66	2	471-061	2-44	8
	24-221	4		8-60	5		17-50	1
	24-304	1		9-68	1		24-258	2
	25-22	2		10-32	1		25-21	4
143-696	24-257	1		17-46	1		25-31	10
143-783	25-19	1		27-20	2	471-062	2-33	18
143-794	24-183	1	280-174	4-63	3		17-13	2
143-801	24-206	2		5-64	3		24-56	2
	24-213	2		6-64	3		24-184	4
	24-237	2		7-65	3	471-063	24-158	8
146-020	22-15	1		8-59	3		24-214	4
146-402	24-250	1	280-373	24-265	1		24-251	2
	25-25	1	280-994	24-326	8		24-321	8
146-448	24-242	3	280-998	9-72	3	471-064	24-305	2
146-998	24-187	1		10-33	2	471-068	2-42	8
148-003	24-181	1		11-44	1	471-069	2-47	8
							25-58	2

NUMERICAL INDEX

1809993

VR-3000 VIDEO TAPE RECORDER

PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART
471-143	25-79	2	477-372	24-287	1	501-635	24-256	1
471-326	24-194	4		24-289	1	501-637	2-24	1
471-327	2-23	2	492-007	25-75	4	501-660	24-84	2
	24-188	2	492-008	24-260	1	501-684	2-31	9
	24-229	2	492-010	25-10	2	502-001	2-12.2	1
	24-233	1	492-466	24-108	10		24-49	1
	24-236	2	496-004	2-25	2		24-145	1
	24-310	4		10	2	502-002	2-34	18
	25-50	4		17-16	2		24-9	8
471-328	24-243	6		17-52	1		24-41	2
471-339	25-70	1		24-160	8		24-43	2
471-388	2-40	3		24-186	4		24-57	2
471-449	25-14	1		24-189	2		24-70	2
471-471	25-5	2		24-230	2		24-117	2
471-496	24-3	2		24-234	1		24-122	2
471-976	2-36	2		24-261	1		24-125	2
472-113	24-144	1		24-271	2		24-137	2
	24-172	3		24-302	2		24-139	2
	24-177	3		24-324	16		24-154	3
472-289	25-81	6		25-20	4		24-247	4
472-303	24-29	4	496-005	25-51	4	502-003	24-306	2
472-448	2-12.1	1	496-007	25-71	1		24-4	2
472-453	24-48	1		24-60	3		24-281	1
472-454	22-16	2		24-62	1		24-293	1
	22-80	2		25-44	4	502-004	24-74	2
	24-283	4	498-286	25-36	1		24-157	2
472-455	24-106	10	501-002	17-14	2	502-023	24-90	2
472-456	24-89	2		17-51	1		24-107	10
472-469	25-74	4	501-008	10	2		24-173	3
475-001	2-51	1		24-159	8		24-178	3
	2-12.3	2		24-168	3		24-255	1
	24-212	2		24-171	2		24-284	4
	24-228	1		24-176	2	502-024	2-45	8
	24-232	2		24-197	4		24-215	4
	24-295	2		24-205	2		24-252	2
	24-328	2		24-219	4		24-296	2
	24-330	2		24-223	8	502-025	2-43	8
	24-332	2		24-253	2		2-48	8
	24-334	2		24-303	4		25-15	1
475-027	25-24	4		24-307	2		25-60	2
	25-26	2		24-322	24	502-027	24-13	1
475-046	24-196	4	501-009	24-5	2		24-25	1
	24-312	1		24-202	4	502-028	25-37	1
475-053	24-218	4		25-16	1	502-121	24-130	1
475-055	24-167	3		25-59	2	503-016	24-323	16
	24-170	2	501-049	24-239	4	503-054	19-61	14
	24-175	2		24-298	AR	506-013	24-192	1
	24-204	2	501-055	22-81	2		24-264	1
475-057	24-199	1		24-299	AR		25-72	1
475-058	24-191	1	501-057	24-131	1	506-021	24-314	1
	24-201	4	501-058	24-300	AR	510-012	2-26	
	24-263	1	501-071	25-40	1	530-154	25-80	6
	24-267	3	501-155	24-91	2	540-006	20-29	1
475-084	25-68	2	501-169	2-5.2	1		21-29	1
475-103	24-207	4		2-12.4	2	540-007	4-25	1
	24-222	8		24-208	4		5-25	1
	24-238	4		24-216	4		6-25	1
	24-320	8		24-269	2		7-25	1
476-024	2-22	1		25-27	2		8-23	1
476-068	24-104	10		25-32	10		9-17	1
	24-127	4	501-221	2-38	AR		13-26	2
			501-233	24-285	4		20-30	1

NUMERICAL INDEX

VR-3000 VIDEO TAPE RECORDER

1809993

PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART	PART NUMBER	FIG & INDEX NO.	QTY PER ART
540-007	21-31	1	586-160	3-37	1			
	22-18	2		11-41	10			
540-009	22-21	1		13-59	9			
540-014	21-30	1		14-52	9			
540-041	22-19	1		21-69	12			
540-052	20-28	2	586-161	3-2	2			
	22-20	1		19-1	3			
540-063	13-25	2	586-162	21-1	5			
540-077	21-28	5	600-095	25-42	AR			
541-080	20-27	2	600-098	25-8	AR			
560-295	22-78	1	6000001-20	24-63	1			
580-080	26-5	6		24-103	2			
580-081	26-8	5	6000007-20	25-39	1			
580-093	16-49	2	6000035-01	2-20	1			
580-143	17-15	1						
580-160	12-73	5						
586-019	3-1	1						
	11-6	1						
	13-2	1						
	21-3	3						
586-020	4-1	1						
	5-1	1						
	6-1	1						
	7-1	1						
	8-1	1						
586-021	4-3	2						
	5-3	2						
	6-3	2						
	7-3	2						
	8-3	2						
	11-3	4						
	13-4	1						
	21-2	2						
586-022	11-5	1						
586-024	10-1	1						
	11-7	1						
	12-1	5						
	13-1	7						
	14-1	9						
	17-1	1						
586-051	27-1	2						
	4-2	2						
	5-2	2						
	6-2	2						
	7-2	2						
	8-2	2						
	11-1	2						
	12-2	1						
	13-3	1						
	14-2	1						
	21-5	2						
586-052	11-4	3						
	21-4	1						
586-060	9-1	1						
	11-1	3						
	21-6	2						
586-149	3-38	2						
	11-42	5						
	12-74	1						
	13-60	1						
	14-53	1						
	19-60	3						
	21-70	3						

VENDOR INFORMATION

1809993

VR3000 VIDEO TAPE RECORDER

FIG. & INDEX NO.	PART NUMBER	NAME & ADDRESS	FIG. & INDEX NO.	PART NUMBER	NAME & ADDRESS
21-1	SN5510L	Same as 9-26	24-16	07-10-101-12	South Chester Corp.
21-2	U5B991429XUL914	Same as 3-1			Southco Div.
21-3	U5B992329XUL923	Same as 3-1			3rd & Governor Printz
21-4	U5F992629X	Same as 3-1			Lester, Pa. 19113
21-5	U5F992729X	Same as 3-1	24-18	DE-41	Armstrong Cork
21-6	U5B77139X	Same as 3-1			W. Liberty & Mary
21-7	FD777	Same as 3-1			Lancaster, Pa 17604
21-28	WEE-0.33	Same as 3-15	24-24	SDL-BC1-62	Same as 24-12
21-29	WEE-100	Same as 3-15	24-30	TJ405BL	Same as 12-21
21-30	WEE-15	Same as 3-15	24-31	TJ408W	Same as 12-21
21-31	WEE-470	Same as 3-15	24-32	TJ403R	Same as 12-21
21-32	DD27.0 (5%)	Same as 3-15	24-65	SDL-AC5-62	Same as 24-12
21-33	VIH6.80	Same as 3-15	24-79	79-012-062-0625	Elastic Stop Nut Corp.
21-34	VIH-4.7	Same as 3-15			P.O. Box 7707
21-35	VIH-3.30	Same as 3-15			Van Nuys, Calif.
21-36	VIH-2.2	Same as 3-15	24-88	111SM1	Honeywell Inc.
21-37	2N2501	Same as 3-1			Microswitch Div.
21-68	1N753A	Same as 3-2			Chicago & Spring Sts.
21-69	7717-38	Same as 3-37	24-93	79-012-062-0375	Freeport, Ill. 61032
21-70	7717-30	Same as 3-37	24-111	28-GB-2	Same as 24-79
21-71	10080	Same as 9-69			Daven Division
21-72	207-080501-00	Same as 20-69			Edison Industries
22-1	1N663	Same as 3-1			Greiner-Municipal Airport
22-2	FD777	Same as 3-1			Manchester, N.H. 03103
22-15	DA-155	ITT Cannon Elec. 3208 Humboldt St. Los Angeles, Cal. 90031	24-114	9A30-01-3-3N	Grayhill, Inc.
22-17	DD470	Same as 3-15			561 Hillgrove
22-18	WEE-470	Same as 3-15	24-155	MABA2	LaGrange, Ill. 60525
22-19	WEE-18	Same as 3-15			Vemaline Prod.
22-20	WEE-6.8	Same as 3-15			511 Commerce
22-21	WEE-2.2	Same as 3-15	24-165	MK-25	Franklin Lakes, N.J. 07417
22-23	2N2501	Same as 3-1	24-181	C-11	Same as 3-2
22-24	2N2219	Same as 3-1			Switchcraft, Inc.
22-25	2N3251	Same as 3-1			5527 N. Elston
22-26	MD2369A	Same as 3-2	24-182	31-221	Chicago, Ill. 60630
22-27	SM4920	Same as 9-26			Amphenol Conn. Div.
22-28	MD918A	Same as 3-2			2801 S. 25th Ave.
22-29	2N2222	Same as 3-1	24-183	165-32	Broadview, Ill. 60153
22-30	2N709	Same as 3-1	24-187	XLR-3-31	Same as 24-182
22-31	2N2402	Sprague Elec. Pembroke Rd. Concord, N.H.	24-190	1/4-3	Same as 22-15
		Same as 9-26			Weckesser, Inc.
		Relcom			4444 West Irving Park
		2164 E. Middlefield Rd. Mountain View, Cal. 94040	24-192	D-140	Chicago, Ill. 60641
22-82	10080	Same as 9-69	24-206	2AH10/1AN5	Same as 24-190
22-83	TP501	Same as 9-72			Viking Industries
23-3	2N2222	Same as 3-1			21001 Nordhoff St.
23-4	2N2219	Same as 3-1			Chatsworth, Calif.
23-5	SM4920	Same as 9-26	24-213	2AH10/1AN5	Same as 24-206
23-6	2N3251	Same as 3-1	24-217	2AH22/1ANS	Same as 24-206
23-18	1N752A	Same as 3-1	24-221	2AH22/1ANS	Same as 24-206
23-19	10080	Same as 9-69	24-237	2AH10/1AN5	Same as 24-206
23-20	TP-501	Same as 9-72	24-242	2AH18/1AN3	Same as 24-206
24-12	SCL-BC11-62	Techlite, Inc. 916 W. South Temple Salt Lake City, Utah 84401	24-250	2AH6/1AN5	Same as 24-206
			24-257	2DA31S	Same as 22-15
			24-262	3/16-3	Same as 24-190
			24-264	D-140	Same as 24-190
			24-277	10105	Same as 9-69
			24-282	111SM1	Same as 24-88
			24-304	2AH22/1ANS	Same as 24-206
			24-313	3/8-6	Same as 24-190

VENDOR INFORMATION

1809993

VR3000 VIDEO TAPE RECORDER

FIG. & INDEX NO.	PART NUMBER	NAME & ADDRESS	FIG. & INDEX NO.	PART NUMBER	NAME & ADDRESS
24-314 24-326	D-128 210-6103	Same as 24-190 Bendix Corp., Compo.Div. 1001 S. Grand Ave. Santa Ana, Calif. 92701	29-27 29-28 29-29 29-30	1N941 TO-18180 1 DEL TP-501 PR-11	Same as 3-2 Same as 3-40 Same as 9-72 Pacific Semiconductor Box 3213 Terminal Annex Los Angeles, Cal. 90054
25-4 25-7 25-9	MDA 952-2 7277-2-1 1N4385	Same as 3-2 Same as 9-26 ITT Semiconductors Div. 1801 Page Mill Rd. Palo Alto, Calif. 94304	29-31	TR101	Inland Electronics Prod. 323 Washington Blvd. Pasadena, Calif. Same as 3-37
25-17 25-18 25-19 25-22 25-25 25-29	SDL-AC1-66 SDL-AC5-66 165-15 2AH22/1ANS 2AH6/1AN5 1909-0198486	Same as 24-12 Same as 24-12 Same as 24-182 Same as 24-206 Same as 24-206 Weston Instruments, Inc. 614 Frelinghuysen Ave., Newark, N. J. 07114	29-32	7717-106 DAP	
25-35	PM-6 W/18567-2	Arrow-Hart & Hegeman 103 Hawthorne St. Hartford, Conn. 06106			
25-41	MST-105D	Alco Electronics 3 Wolcott Ave. Lawrence, Mass. 01843			
25-55 25-67 25-69	1N4385 FCA4 742-7	Same as 25-9 Same as 24-155 Commercial Plastics 959 George St. Chicago, Ill. 60657			
25-73	S3-175	DZUS Fastener Co. 425 Union Blvd. West Islip, N.Y. 11795			
25-83	5S27-11	Camloc Fastener Corp. 22 Spring Valley Rd. Paramus, N. J. 07652			
25-84 26-2 26-4 26-5 26-6 26-7 26-8 26-9 26-10 26-23 27-1 27-6 27-7 27-19 27-20 27-21 28-9 28-17 28-34 28-37 28-48 29-1 29-2 29-7 29-10	5S3-1 1N4385 2N2907A TD101 2N2222 2N3251 TD401 2N2501 S3568 TO-18180 1 DEL μ A709C 2N3251 2N2501 1N825 7719-19-DAP TO-18180 1 DEL 165-15 2AH10/1AN3 MK-15 MST 205N 3/8-6 1N914 MR1031B 2N2907A 2N3945	Same as 25-83 Same as 25-9 Same as 3-1 Same as 22-31 Same as 3-1 Same as 3-1 Same as 22-31 Same as 3-1 Same as 3-1 Same as 3-40 Same as 3-1 Same as 3-1 Same as 3-1 Same as 3-2 Same as 3-37 Same as 3-40 Same as 24-182 Same as 24-206 Same as 3-2 Same as 25-41 Same as 24-190 Same as 9-26 Same as 3-2 Same as 3-1 Same as 10-10			

VENDOR INFORMATION

1809993

VR3000 VIDEO TAPE RECORDER

FIG. & INDEX NO.	PART NUMBER	NAME & ADDRESS	FIG. & INDEX NO.	PART NUMBER	NAME & ADDRESS
21-1	SN5510L	Same as 9-26	24-16	07-10-101-12	South Chester Corp.
21-2	U5B991429XUL914	Same as 3-1			Southco Div.
21-3	U5B992329XUL923	Same as 3-1			3rd & Governor Printz
21-4	U5F992629X	Same as 3-1			Lester, Pa. 19113
21-5	U5F992729X	Same as 3-1	24-18	DE-41	Armstrong Cork
21-6	U5B77139X	Same as 3-1			W. Liberty & Mary
21-7	FD777	Same as 3-1			Lancaster, Pa 17604
21-28	WEE-0.33	Same as 3-15	24-24	SDL-BC1-62	Same as 24-12
21-29	WEE-100	Same as 3-15	24-30	TJ405BL	Same as 12-21
21-30	WEE-15	Same as 3-15	24-31	TJ408W	Same as 12-21
21-31	WEE-470	Same as 3-15	24-32	TJ403R	Same as 12-21
21-32	DD27.0 (5%)	Same as 3-15	24-65	SDL-AC5-62	Same as 24-12
21-33	VIH6.80	Same as 3-15	24-79	79-012-062-0625	Elastic Stop Nut Corp.
21-34	VIH-4.7	Same as 3-15			P.O. Box 7707
21-35	VIH-3.30	Same as 3-15			Van Nuys, Calif.
21-36	VIH-2.2	Same as 3-15	24-88	111SM1	Honeywell Inc.
21-37	2N2501	Same as 3-1			Microswitch Div.
21-68	1N753A	Same as 3-2			Chicago & Spring Sts.
21-69	7717-38	Same as 3-37	24-93	79-012-062-0375	Freeport, Ill. 61032
21-70	7717-30	Same as 3-37	24-111	28-GB-2	Same as 24-79
21-71	10080	Same as 9-69			Daven Division
21-72	207-080501-00	Same as 20-69			Edison Industries
22-1	1N663	Same as 3-1			Greiner-Municipal Airport
22-2	FD777	Same as 3-1			Manchester, N.H. 03103
22-15	DA-155	ITT Cannon Elec. 3208 Humboldt St. Los Angeles, Cal. 90031	24-114	9A30-01-3-3N	Grayhill, Inc.
22-17	DD470	Same as 3-15			561 Hillgrove
22-18	WEE-470	Same as 3-15	24-155	MABA2	LaGrange, Ill. 60525
22-19	WEE-18	Same as 3-15			Vemaline Prod.
22-20	WEE-6.8	Same as 3-15			511 Commerce
22-21	WEE-2.2	Same as 3-15	24-165	MK-25	Franklin Lakes, N.J. 07417
22-23	2N2501	Same as 3-1	24-181	C-11	Same as 3-2
22-24	2N2219	Same as 3-1			Switchcraft, Inc.
22-25	2N3251	Same as 3-1			5527 N. Elston
22-26	MD2369A	Same as 3-2	24-182	31-221	Chicago, Ill. 60630
22-27	SM4920	Same as 9-26			Amphenol Conn. Div.
22-28	MD918A	Same as 3-2			2801 S. 25th Ave.
22-29	2N2222	Same as 3-1	24-183	165-32	Broadview, Ill. 60153
22-30	2N709	Same as 3-1	24-187	XLR-3-31	Same as 24-182
22-31	2N2402	Sprague Elec. Pembroke Rd. Concord, N.H.	24-190	1/4-3	Same as 22-15
		Relcom			Weckesser, Inc.
		2164 E. Middlefield Rd. Mountain View, Cal. 94040	24-192	D-140	4444 West Irving Park
22-32	2N491	Same as 9-26	24-206	2AH10/1AN5	Chicago, Ill. 60641
22-78	B8T	Same as 9-26			Same as 24-190
		2164 E. Middlefield Rd. Mountain View, Cal. 94040			Viking Industries
22-82	10080	Same as 9-69	24-213	2AH10/1AN5	21001 Nordhoff St.
22-83	TP501	Same as 9-72	24-217	2AH22/1ANS	Chatsworth, Calif.
23-3	2N2222	Same as 3-1	24-221	2AH22/1ANS	Same as 24-206
23-4	2N2219	Same as 3-1	24-237	2AH10/1AN5	Same as 24-206
23-5	SM4920	Same as 9-26	24-242	2AH18/1AN3	Same as 24-206
23-6	2N3251	Same as 3-1	24-250	2AH6/1AN5	Same as 24-206
23-18	1N752A	Same as 3-1	24-257	2DA31S	Same as 22-15
23-19	10080	Same as 9-69	24-262	3/16-3	Same as 24-190
23-20	TP-501	Same as 9-72	24-264	D-140	Same as 24-190
24-12	SCL-BC11-62	Techlite, Inc. 916 W. South Temple Salt Lake City, Utah 84401	24-277	10105	Same as 9-69
			24-282	111SM1	Same as 24-88
			24-304	2AH22/1ANS	Same as 24-206
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25-35	PM-6 W/18567-2	Arrow-Hart & Hegeman 103 Hawthorne St. Hartford, Conn. 06106			
25-41	MST-105D	Alco Electronics 3 Wolcott Ave. Lawrence, Mass. 01843			
25-55 25-67 25-69	1N4385 FCA4 742-7	Same as 25-9 Same as 24-155 Commercial Plastics 959 George St. Chicago, Ill. 60657			
25-73	S3-175	DZUS Fastener Co. 425 Union Blvd. West Islip, N. Y. 11795			
25-83	5S27-11	Camloc Fastener Corp. 22 Spring Valley Rd. Paramus, N. J. 07652			
25-84 26-2 26-4 26-5 26-6 26-7 26-8 26-9 26-10 26-23 27-1 27-6 27-7 27-19 27-20 27-21 28-9 28-17 28-34 28-37 28-48 29-1 29-2 29-7 29-10	5S3-1 1N4385 2N2907A TD101 2N2222 2N3251 TD401 2N2501 S3568 TO-18180 1 DEL μ A709C 2N3251 2N2501 1N825 7719-19-DAP TO-18180 1 DEL 165-15 2AH10/1AN3 MK-15 MST 205N 3/8-6 1N914 MR1031B 2N2907A 2N3945	Same as 25-83 Same as 25-9 Same as 3-1 Same as 22-31 Same as 3-1 Same as 3-1 Same as 22-31 Same as 3-1 Same as 3-1 Same as 3-1 Same as 3-40 Same as 3-1 Same as 3-1 Same as 3-1 Same as 3-2 Same as 3-37 Same as 3-40 Same as 24-182 Same as 24-206 Same as 3-2 Same as 25-41 Same as 24-190 Same as 9-26 Same as 3-2 Same as 3-1 Same as 10-10			